STATUS, DISTRIBUTION AND SOME ASPECTS OF ECOLOGY OF CHEER PHEASANT *Catreus wallichii* IN HIMACHAL PRADESH, INDIA

ABSTRACT

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN

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BY

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ABSTRACT

The pheasants have been associated with the mankind since times immoral. They are known as game birds as they are hunted for sport as well as pot. They constitute most distinctive family of bird of the Himalayas and have most fascinating, spectacular and gorgeously plumaged birds of the world. The family phasianidae comprises of a group of 49 species of generally non-migratory and terrestrially adapted birds of moderately large size of which 17 species are found in India. There are seven species of pheasants found in Himachal Pradesh out of which two species have been put under threat category. There is lack of detailed ecological information on Cheer pheasant in Himachal pradesh. The study was taken to look at the status, distribution and some aspects of ecology of the Cheer pheasant.

The study was conducted in Majathal-Harsang Wildlife Sanctuary of of 39 km^2 area. The sanctuary lies to northwest of Shimla in the catchment of River Sutlej, situated in the districts of Shimla and Solan.

The basic vegetation in the study area was classified as Chir pine *Pinus roxburghii* and Ban Oak *Quercus lecotrichophora* categories. The habitat was categorized into seven-habitat categories – a) Dense pine. b) Open pine. c) Oak. d) Scrub. e) Grassland. f) Degraded. g) Cultivation. The study was conducted for three seasons for two constitutive years, while call counts were done for three constitutive years.

To find the status of Cheer pheasant, call counts were done at the cheer calling sites in the sanctuary. The mean density of cheer over the years was 5.612 ± 0.453 calling positions per square kilometer. The mean calling density in year 1999 was 3.289 ± 0.730 calling

positions per square kilometer, while in year 2000 it was 4.448 ± 0.560 calling positions per square kilometer and in year 2001 it was 5.162 ± 0.453 calling positions per square kilometer. The mean density index varied significantly across the years ($F = 14.547$, $df = 2$, $p < 0.01$, One-way ANOVA).

The mean density index in the month of April was 2.551 ± 0.808 calling positions per square kilometer, while in the month of May it was 8.241 ± 0.590 calling positions per square kilometer and in the month of June it was 4.034 ± 0.749 calling positions per square kilometer. The mean calling positions varied significantly across the months ($F = 17.082$, $df = 2$, $p < 0.01$, One-way ANOVA).

Six cheer sites were monitored for three years. Six new cheer sites were found in and around the protected area. One cheer site, Matrech was situated in the jurisdiction of Bilaspur district. There were no significant differences in the density indices at these new sites ($F = 1.39$, $df = 5$, $p = 0.246$, One-way ANOVA).

The calling frequency at dawn varied from 44 to 75 % in the year 2000, while it varied from 22 % to 77 % in the year 2001. The calling frequency varied significantly across the months in year 2000 ($F = 10.16$, $df = 2$, $p < 0.05$, One-way ANOVA) and also varied significantly in year 2001 ($F = 30.81$, $df = 2$, $p < 0.05$, One-way ANOVA). At dusk, the calling frequency varied from 32 to 90 % in year 2000 and in it year 2001 it varied from 22 to 75 %. The calling frequency varied significantly across the months in year 2000 ($F = 47.78$, $df = 2$, p , 0.05, One-way ANOVA) and it also varied significantly across the months on the year 2001 ($F = 23.48$, $df = 2$, One-way ANOVA). The birds were more vocal in the month of May in both the years and same at dawn as well as dusk.

The mean duration of calling at dawn in year 2000 was 5.08 minutes (± S. E. 0.32). In the month of April, it was 2.12 minutes (± S.E. 0.24) while in the month of May it was 8.42 minutes (± S.E. 1.01) and in the month of June it was 2.15 minutes (± S.E. 0.32). The mean duration of calling varied across the months ($F = 21.830$, $df = 2$, $p < 0.05$, One-way ANOVA). The mean duration of calling at dawn in year 2001 was 6.15 minutes (± S.E. 0.22). The mean duration of calling in at dawn in the month of April was 2.37 minutes (± S.E. 0.41), while the duration of calling in the month of May was 7.56 minutes (± S.E. 0.32) and in the month of June it was 6.35 minutes (± S.E. 0.36). The mean duration of calling varied across the months ($F = 19.28$, $df = 2$, $p < 0.05$, One-way ANOVA).

The mean duration of calling at dusk in year 2000 was 4.16 minutes (± S.E. 0.20). The mean calling duration in the month of April was 3.12 minutes (± S.E. 0.35) while in the month of May it was 6.47 minutes (± S.E. 0.32) and the mean calling duration in the month of June was 1.07 minutes (± S.E. 0.20). The mean duration of calling at dusk varied significantly across the months ($F = 32.84$, $df = 2$, $p < 0.05$, One-way ANOVA). The mean calling duration at dusk in the year 2001 was 3.10 minutes (± S.E. 0.16). The mean duration of calling in the month of April was 1.44 minutes (± S.E. 0.32) while in the month of May it was 4.30 (± S.E. 0.27 (and in the month of June it was 2.53 minutes (± S.E. 0.16). The mean duration of the calling varied significantly across the months ($F = 9.62$, $df = 2$, $p < 0.05$, One-way ANOVA). The duration of calling was longest in the month of May in both the years.

The mean number of calls at dawn in year 2000 was 29.19 calls per calling day (± S.E. 1.65). The mean number of calls in the month of April was 21.07 calls per calling day (± S.E. 2.80) while in the month of May it was 44.2 calls per calling day (± S.E. 2.05) and in the month of June was 11.49 calls per calling day (± S.E. 1.94). The mean number of calls varied significantly across the months ($F = 59.34$, df – 2, $p < 0.05$, One-way ANOVA). In year 2001, at dawn, the mean number of calls was 32.60 calls per calling day (± S.E. 1.28). The mean number of calls in the month of April was 10.57 (± S.E. 1.28) per calling day, while in the month of May it was 43.68 (± S.E. 1.47) calls per calling day and in the month of June it was 33.32 (± S.E. 1.99) calls per calling day. The number of calls varied significantly across the months ($F = 82.01$, df = 2, $p < 0.05$, One-way ANOVA). The number of calls was maximum in the month of May in both the years.

The mean numbers of calls at dusk in year 2000 were 18.09 (± S.E. 1.05) calls per calling day. The mean number of calls in the April was 13.35 calls (± S.E. 1.88) per calling day while in the month of May it was 29.14 calls (± S.E. 0.89) and in the month of June it was 4.37 (± S.E. 0.89) calls per calling day. The mean number of calls varied significantly across the months ($F = 106.76$, df = 2, $p < 0.05$, One-way ANOVA). In year 2001 the mean number of calls was 23.74 calls (± S.E. 1.30) per calling day. The mean number of calls in the month of April was 10.55 calls (± S.E. 2.04) per calling day, while in the month of May mean number of calls were 34.70 (± S.E. 1.67) per calling day and in June mean number of calls was 22.68 (± S.E. 2.17) calls per calling day. The mean number of calls varied significantly across the months ($F = 38.41$, df = 2, $p < 0.05$, One-way ANOVA). The mean number of calls was highest in the month of May in both the years.

Sightings of Cheer pheasant in different habitat types was used to work out the habitat use pattern of this species in the area. At each bird plot both landscape and microhabitat variables were collected. To determine which particular habitat had been utilized by Cheer pheasant more or less than expected in proportion to its availability, Bonferoni 95% confidence intervals were used.

Overall Cheer utilized open-pine , scrub and grassland were utilized more then the expected while oak, degraded and cultivation were utilized less then the expected. The seasonal sightings of cheer differed in different habitats. Scrub and grassland were utilized more then the expected in the post-breeding season, while dense-pine, oak, degraded and cultivation was utilized less then the excepted in this season. In winter season, dense-pine and open-pine was utilized more then the expected, while oak, cultivation and degraded were utilized less then the expected. In breeding season open-pine, scrub and grassland were utilized more then the expected while oak, degraded and cultivation was utilized less then the expected.

At landscape level, all the variables varied significantly between the random and the cheer plots. Forest, terracing and bare ground were more in random plots as compared to cheer plots while grass and scrub were more in cheer plots as compared to random plots.

At microhabitat level, number of trees, canopy cover, number of sapling and shrub cover at 1.5 meter were having higher vales in random plots as compared to cheer plots while mean girth at breast height of trees, number of shrub species, shrub cover at 0.5 meter, shrub cover at 1 meter, shrub height, shrub heterogeneity, ground cover and ground cover height were having higher vales in cheer plots as compared to random plots in first year.

In second year, mean girth at breast height, number of shrub species, shrub cover at 0.05 meter, shrub cover at 1 mete, shrub height, shrub heterogeneity, ground cover, ground cover height, number of sapling species and number of sapling were having higher values in cheer plots as compared to random plots. The microhabitat variables also varied significantly in post-breeding season, winter and in breeding season between random and cheer plots.

In first year, Principal Component Analysis (PCA) extracted four factors which cumulatively accounted for 78.41 % of variance. Component first explained forest cover, which was heading from open to mature forest. The second component explained high shrub cover with low ground cover. The third component explained high ground cover with low forest cover. The fourth component explained high ground cover with low forest and shrub cover.

In post breeding season, in first year, PCA extracted four factors which cumulatively accounted for 81.16 % of the variation, while in winter season the first four factors explained 78.41% of the variation and in breeding season first four factors explained 83.59 % of the variation.

In second year, PCA extracted four components which accounted for 78.69 % of variance. The first component explained high forest cover with low shrub cover. The second component was having high shrub cover with low ground cover. The third component was having high ground cover with low shrub cover while fourth component explained forest regeneration with low ground and shrub cover.

In post breeding season, first four component explained 80.41 5 of the variation, while in winter the first four component explained 82.67 % of the variation and in the breeding season the first four factors explained 77.90 % of the variation.

During the study, data on social organisation (flock size, flock composition and sex ration) were collected. Each sighting was considered as a flock. The maximum sighting was of the 2-3 birds, while single bird was sighted at 20 times. The mean flock size in the non-breeding season was 4.55 (± 0.35 S.E.) birds per flock, while in the winter season mean flock size was 3.79 (± 0.927 S.E.) birds per flock and in the breeding season the mean flock size was 2.16 (± 0.106 S.E.).

A total of 507 birds were sighted in 160 sightings. The over all sex ratio across the seasons was 134:100 males per female, In non-breeding season sex ratio was 167:100 males per female and in breeding season it was 137:100 males per female. There was no significant difference in the sex ratio between the season ($F= 0.218$, $df = 2$, $p = 0.804$, One-way ANOVA). The sightings of males were higher in all the seasons.

Fire wood, timber and grass were the important resources which were extracted by the locals from the sanctuary. The extraction of the fuel wood did not vary across the villages ($F= 1.059$, $df =10$, $p = 0.408$, One-way ANOVA), while the grass extraction also did not vary across the villages ($F = 1.373$, $df = 10$, p 0.217, One-way ANOVA). The presence/absence of grass cutting varied significantly between cheer and random plots ($U = 105611$, $p =0.00$, Mann-Whitney U-test) while the presence/absence of human trails also varied significantly between random and cheer plots ($U = 11670$, $p =0.00$, Mann-Whitney U test). The number of the cut stems varied significantly between random and cheer plots ($F= 15.897$, $df = 1$, One-way ANOVA), while the number of lopped trees did not vary significantly between cheer and random plots. The number of the dung piles did not vary significantly between cheer and random plots, while the number of the dung piles was more in random plots as compared to cheer plots.

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Dedicated to my

Late Grandmother

And

Other Loved Ones……

DEPARTMENT OF WILDLIFE SCIENCES

ALIGARH MUSLIM UNIVERSITY, ALIGARH - 202 002 (INDIA)

CERTIFICATE

This is to certify that the thesis titled **"Status, distribution and some aspects of ecology of cheer pheasant *Catreus wallichii* in Himachal Pradesh, India"** submitted for the award of Ph. D. degree in Wildlife Science, of the Aligarh Muslim University, Aligarh is the original work of **Mr. Junid Nazeer Shah**. This work has been done by the candidate under my supervision.

Jamal A. Khan

Jamal A. Khan, Ph. D.

Dated: 30th December 2004

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Certificate

This is to certify that the thesis "Status, distribution and some aspects of ecology of Cheer pheasant *Catreus wallichii* in Himachal Pradesh, India" submitted for the award of Ph.D. degree in Wildlife Science, of the Aligarh Muslim University, Aligarh is the original work of **Junid Nazeer Shah**. This work has been done by the candidate under my co-supervision.

Rajiv Kalsi

Rajiv S. Kalsi, Ph.D.
Department of Zoology

CHEER PHEASANT

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Junid N. Shah

CONTENTS

List of Tables

List of Figures

Chapter 1

Introduction

Pheasants have been associated with mankind since times immemorial. Known as the game birds (Lack 1971) as they are hunted for sport as well as for pot. Pheasants occur all along the Himalayas and constitute one of the most beautiful and conspicuous family of birds in the world (Young and Kaul 1987). The plumage in most of the male pheasants is striking while females are cryptic. Facial adornments in the form of crests, wattles, ruffs and hackles are present in the males. Pheasants inhabit fragile habitats, which are effected by human pressures.

1.1 Taxonomy of pheasants

The order Galliformes is a group of small to very large terrestrial birds. The presence of the lateral foramen delineated by fused manubrial spines of sternum is the only taxonomic character to indicate that the order is monophyletic (Urban *et al.* 1986). Many authors support the view that Galliform birds are most closely related to Anseriformes, perhaps linked by the screamers (Anhimidae) (Urban *et al.*1986, del Hoyo *et al.* 1994). Of the families included in this order, family Phasianiadae is the largest and the most diverse assemblage. The species have rather short, stout, sometimes strongly spurred tarsi (larger in males), plump body, short bill, rounded wings and short to very long tail (Johnsgard 1986, del Hoyo *et al.* 1994, Fuller and Garson 2000).

The family Phasianidae comprises of 38 genera, 155 species and 399 taxa distributed throughout much of the old world with greater diversities in S.E. Asia and Africa (del Hoyo *et al.* 1994, McGowan and Garson. 1995, Fuller and Garson 2000). Attempts have been made earlier, by the taxonomists to classify this group. Beebe (1914) used the sequence of moulting in the retrices (tail feathers) as the main criterion of generic grouping. According to this criterion Genus *Ithaginus* (Blood pheasants) and *Trgopans* (Tragopan pheasants) were grouped with partridge like species and were included in the subfamily Perdicinae (centrifugal moulting pattern). The typical peafowls (moulting beginning from the second retrices from the outermost, with outermost moulting before the inner ones) and Peacock pheasants and Argus pheasants (moulting beginning with third from central and proceeding outward and inwards similarly) were exception to this family and were placed in the group Pavoninae and Argusianiane respectively.

Perets (1934) included all the old world partirdages, their relatives and the typical pheasants in the in the subfamily Phasianinae. Delacour (1977) included the New World quails also in the subfamily Phasianiae and considered species of the Genus *Ithaginus* and *Tragopan* related to the partridges but consider them sufficiently pheasants-like. Verheyen (1956) proposed a new classification based on measurements of the skull. He classified into three subfamilies- Phasianinae which include pheasants like species, Afropavoninae which included the Congo pheasant and Pavoninae which included the peafowls. Wetmore (1960) placed pheasants under a separate family Phasianidae under the superfamily Phasianoidea. Sibley and Ahlquist (1972) suggested the typical pheasants to be included in a separate subfamily phasianinae Johnsguard (1973, 1986) classified the pheasants as a separate subfamily Phasianinae under the broad family Phasianidae. This subfamily was further classified into the tribe Phasianini that included the pheasants exclusively. Wolters (1975-82) considered the Guinea Fowl amongst one of the 15 subfamilies of the family Phasianidae and proposed that the typical pheasants to be divided into eight separate subfamilies. This classification was most widely followed. More recently, Sibley and Monroe (1990) based their classification on DNA-DNA hybridization and classified the pheasants and old world partridges, quails and francolins in the family Phasianidae.

1.2 Distribution of pheasants

Out of the sixteen genera (Delacour 1977) and 51 species (69 taxa) of pheasants known to us, 50 species are endemic to Asia (McGowan and Garson 1995, Fuller & Garson 2000) except one specie the Congo pheasant *Afropavo congensis* which is native to Zaire in Central Africa (Crowe *et al.* 1986). Several species of pheasants have been introduced outside their native home in Europe and USA for sport-hunting (Bump 1941, Pokorny and Pikula 1987, Hill and Robertson 1988a). The globally distributed domestic fowl is believed to have originated from Red Junglefowl *Gallus gallus* (Wood-Ghush 1959). The most common and widely distributed pheasant in Europe and North America is the Chinese Ringed-necked Pheasant *Phasianus colchicus*.

In Asia, pheasants are distributed from Indonesia at 8° S throughout to northeastern China at 50° N and from 45° E in the Caucasus to 145° E in Japan. All along their distribution range, pheasants are found in diverse habitats like lowland tropical forests (Mountain peacock pheasant *Polyplectron inopinatum)*, temperate coniferous forests (Western tragopan *Tragopan melanocephalus*), Sub-alpine scrub (Blood pheasant *Ithaginius cruentus*), Alpine meadows (Chinese monal *Lophophorus lhuysii*), Montane grass scrub (Cheer pheasant *Catreus wallichii*), Broad-leaved evergreen forests (Kalij pheasants *Lophura spp.* and Koklass pheasant *Pucrasia macrolopha*).

1.3 Pheasant species in India

Out of the total 51 species of pheasants found in the world, 17 species occur in India.

i) Blood pheasant:

Out of the 14 sub-species of Blood pheasant *Ithaginius cruentus* found in the world, three sub-species are distributed in India. *I.c. affinis* has its distribution range in Sikkim, while *I.c. tibetanus* is distributed in the Arunchal Pradesh and *I.c. kuseri* is distributed in central to eastern Arunachal Pradesh.

ii). Tragopan:

There are four species of the tragopans found in India.

a. Western Tragopan *Tragopan melanocephalus*:

The species is distributed from the North of Kashmir to east of Uttaranchal.

b. Satyr Tragopan *Tragopan satyra*:

This species of the tragopan is distributed in Kumaon Himalayas, Darjeeling hills, Sikkim and Arunachal Pradesh.

c. Blyth's Tragopan *Tragopan blythii*

There are two sub-species of Blyth tragopan found in the world. The Indian sub-species is *Tragopan blythii blythii*, is distributed in Assam. Mizorum and Manipur.

d. Temminck's Tragopan *Tragopan temminckii:*

There are no sub-species of this tragopan species. It is distributed in the state of Arunachal Pradesh.

iii) Koklass pheasant:

There are nine sub-species of the Koklass pheasant *Pucrasia macrolopha* in the world. In India two sub species of the Koklass pheasant are found. Kashmir koklass *P. m. biddulphi* is distributed from northern Kashmir to Himachal Pradesh, while Common koklass *P.m. macrolopha* is found from southern Kashmir to Garhwal Himalayas.

iv). Monal:

There are two species of the Monal pheasant in India with the possibility that a third species has been discovered in Arunachal Pradesh (Kumar & Singh 2000).

a. Himalayan Monal *Lophophorus impejanus*: This species of the monal is distributed from the west to east of the Himalayan range.

b. Sclater's Monal *Lophophorus sclateri:* This species of the monal is distributed in the northern fringes of Arunachal Pradesh.

v). Junglefowl:

There are two species of the jungle fowls found in India

a. Red Jungle Fowl *Gallus gallus*: There are four sub-species of the Red junglefowl found in the world while two sub-species are distributed in India. Indian Red Junglefowl *G. g. murhgi* is distributed along the Himalayan foot hills up to an altitude of 2000 m. It is distributed from Kashmir to Arunachal Pradesh southwards to parts of Uttar Pradesh, Madhya Pradesh, Bihar. Orissa, West Bengal and Assam. The other sub-species, Burmese Red junglefowl *G. g. spadicus* is distributed in the eastern Mishimi hills of Arunachal Pradesh.

b. Grey Jungle fowl *Gallus sonneratii*: The Grey junglefowl is distributed in the areas of southern Rajasthan, Madhya Pradesh, Gujarat, Tamil Nadu and Kerala.

vi). Kalij Pheasant:

There are nine sub species of the Kalij pheasant *Lophura leucomelanos* found in the world. This pheasant has the most extensive distribution of all the pheasant groups. It ranges from Pakistan in the west to Indonesia in the east. There are four sub-species found in India. White crested kalij pheasant *L . l. hamiltoni* is distributed in western Himalayas, Black- backed kalij *L .l. melanota* is distributed in east-central Himalayas, Black-breasted kalij *L. l. lathami* is distributed in Arunachal Pradesh and Manipur while William's kalij pheasant *L .l. walliamsi* is distributed in southeast Manipur and the hills of Mizoram.

vii). Eared pheasant:

There are four species of the Eared pheasant found in the world, out of which only one species is found in India.

a. Tibetan Eared pheasant *Crossoptilon harmani*: This species is distributed in the northern parts of Arunachal Pradesh.

viii). Hume's pheasant:

There are two sub-species of Hume's pheasant *Syrmaticus humiae* found in the world, out of which one sub species is found in India. The Indian sub-species *S. h. humiae* is distributed in Manipur, Patkai, Naga and Mizo hills of Northeast India.

ix).Grey peacock – pheasant:

There are five sub species of this Grey Peacock – pheasant *Polyplectron bicalcaratum* pheasant found in the world out of which one sub-species Bhutan peacock-pheasant *P. b. bakeri*. This sub-species is distributed in Sikkim, North Bengal, Arunachal Pradesh, Assam, Manipur and Nagaland.

x). Peafowls:

There are two sub-species found in India.

a. India Peafowl *Pavo cristatus*: This pheasant is distributed up to 1800 m throughout the country.

b. Green Peafowl *Pavo muticus*: There are three sub-species of this pheasant found in the world. One sub-species *P. m. spicifer* is suspected to be present in the areas adjacent to southeastern Bangladesh.

xi). Cheer pheasant:

Cheer pheasant *Catreus wallichii* is distributed from Kashmir through Garhwal to Kumaon Himalayas in India.

1.4 Threats and conservation:

There is very little basic ecological information available on 47 (68%) taxa of Pheasants (Fuller and Garson 2000). Out of the 69 taxa of pheasants, 4 .(6%) are critically endangered with extinction, 16 (23%) are in the endangered list, 24 (35%) are in vulnerable category, 19 (27%) have not been assigned any threat category and 6 (9%) species are put in data deficient category (Fig. 1.1). The main threats to the pheasants along their distribution range are habitat loss, fragmentation, hunting for food, poaching for trade, genetic swamping and of pesticides.

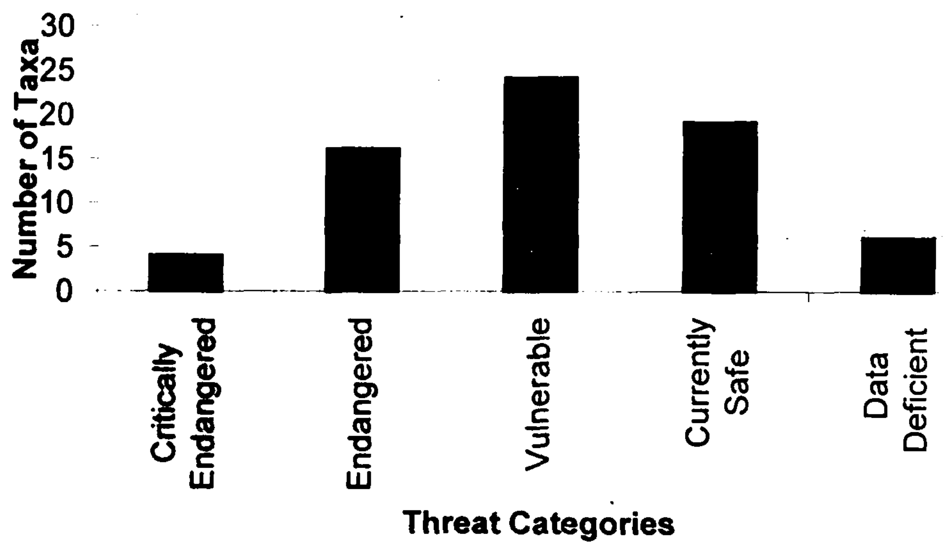


Figure 1.1 Showing threat categories of 69 pheasant taxa.

1.5 Threats faced by Himalayan Pheasants

The pristine habitats in the Himalayan region have been under severe pressure ever since they were opened and exploited commercially in the colonial period, about more than 150 years ago (Tucker 1983). Much more destruction has been witnessed after independence of India in 1947, as these areas became developed on the modern lines (Singh & Singh 1987). With the increase of human and cattle population the demands for land and fodder further led to shrinkage of habitats available for pheasants and it also made inroads for degradation of the quality habitat in the remaining areas. These activities as well as persecution by hunters, has decreased the population of most of the pheasant species substantially, causing local extinction of some species and pushing others to the brink of extinction (Singh & Singh 1987).

Pheasants belong to a highly specialized group of Aves. This group of birds inhabits very fragile habitats where least human exploitive pressure can cause large scale changes and consequently such habitats do not remain suitable for these birds (Garson *et al.* 1992). A number of biotic and a biotic factors have put several species of pheasants under threat. There are six species of pheasants in the Himalayan region that are threatened with extinction (Fuller & Garson 2000, IUCN/SSC/Red Data Book 2003). These species require urgent protection for their long-term conservation in the Indian Himalayas. Further more these species can be used as flagship species for conserving the unique ecosystem in Himalayas.

1.6 Studies on pheasant:

Pheasants have been associated with the mankind from the times immemorial. The domestic fowl, which we relish today, has been in domestication since 5000 B.C. (Wood-Ghush 1959). The first modern investigations, which have been pened down from journeys made in mountains and jungles of Asia, reported on the distribution and behavior of the species (Beebe 1918, 1922, Delacour 1977). "A monograph of Pheasants" (Beebe 1922) and "The Pheasants of the World" (Delacour 1977) are considered as the stepping-stones for any study on pheasants.

Table 1.1 List of pheasant species with different threat categories and their legal status are given below:

S.No	English Name	Scientific Name	IUCN category	WPA Act (1972)	RRS	BS
1	Blood Pheasant	*Ithaginis cruentus*	Not threatened	Schedule I	No	Yes
2	Western Tragopan	*Tragopan melanocephalus*	Vulnerable	Schedule I	Yes	No
3	Satyr Tragopan	*Tragopan satyra*	Not threatened	Schedule I	No	Yes
4	Blyth' Tragopan	*Tragopan blythiii*	Vulnerable	Schedule I	No	Yes
5	Temminck's Tragopan	*Tragopan temminckii*	Not threatened	Schedule I	No	Yes
6	Koklass Pheasant	*Pucrasia macrolopha*	Not threatened	Schedule II	No	Yes
7	Himalayan Monal	*Lophophorus impejanus*	Not threatened	Schedule I	No	No
8	Sclater's Monal	*Lophophorus sclateri*	Vulnerable	Schedule I	No	No
9	Red Junglefowl	*Gallus gallus*	Not threatened	Schedule II	No	No
10	Grey Junglefowl	*Gallus sonneratii*	Not threatened	Schedule II	No	No
11	Kalij Pheasant	*Lophura leucomelanos*	Not threatened	Schedule I	No	No
12	Tibetan Eared-pheasant	*Crossoptilon harmani*	Not threatened	Schedule I	No	No
13	Cheer Pheasant	*Catreus wallichii*	Vulnerable	Schedule I	Yes	No
14	Mrs Hume's Pheasant	*Syrmaticus humiae*	Vulnerable	Schedule I	No	No
15	Grey Peacock-pheasant	*Polyplectron bicalcaratum*	Not threatened	Schedule I	No	No
16	Indian Peafowl	*Pavo cristatus*	Not threatened	Schedule I	No	Yes
17	Green Peafowl	*Pavo muticus*	Vulnerable	Schedule II	No	Yes

WPA= Wildlife Protection Act (1972), RRS = Restricted Range Species, BS = Biome restricted.

1.7 Overview of pheasant studies in Europe and America:

1.7.1 Habitat use:

The distribution patterns by the Wisconsin pheasant during winter were studied using radio telemetry (Gates and Hale 1974). The use of fringed wooded scrub in America by Ring-necked pheasant when woodlands are absent was revealed by Guthery & Withesade (1984). Studying the winter habitat use in Common pheasant in Ireland Robertson (1985) found that, scrub and woodland with scrub were preferred while woodlands with bare grassy under layer, hedge-groves or open fields were avoided and there was a difference in the habitat selection by male and female birds. Hill and Robertson (1988b) found that there was a seasonal variation in the habitat use in Common pheasant. In winter, the birds preferred woodlands while they shifted to growing crops during spring and summer. Females in Southern Wisconsin preferred food patches and brush and avoided pastures and croplands (Gatti *et al.* 1989). Robertson *et al.* (1993a) studied the winter density of Common pheasant in U.K. and found out that a high proportion of shrub cover and the provision of supplementary food were associated with high pheasant densities.

1.7.2 Cover:

The use of the cover during day and night in all the months by Common pheasant in East-Central Dakota was revealed by Hanson and Progulske (1973). The use of the cover by the Ring-necked pheasant broods in east Illinois revealed that oats and hay were mainly used for roosts. In the study on nesting ecology of the species in northeastern Colorado, Snyder (1984) found that winter wheat and post-harvest stubble was dominant nesting cover in spring. The height and density of this cover was affected by the amount of precipitation accumulated in the soil. The study in Oregon on the Common pheasant (Meyers *et al.* 1988) revealed that survival of the broods was related to different cover types and in some cover types survival was a function of the age of the brood.

1.7.3 Population studies:

Study on the population dynamics started way back in 1930s. Errington and Hammerstron (1937) studied the nesting losses and juvenile mortality of Ring-necked pheasant. Green (1938) revealed the importance of food and cover relationship in the winter survival of pheasant in northern Iowa. Eklund (1942) studied the mortality factors effecting the nesting pheasants in the Willamette valley, while population fluctuation was studies in North Dakota (Bach 1944). Buss *et al.* (1951) assessed the significance of adult pheasant mortalities in spring and autumn while Gondahl (1953) studied the winter behavior of pheasants with relation to cover in Winnebago country. Comprehensive studies conducted on the population ecology of Wisconsin pheasant between 1946-61 revealed that high density of the species occurred in areas with 55–70% cultivated lands and showed progressive decline in areas where either more or less than 55–70% land was cultivated (Wagner *et al.*1965). The study using radio-telemetry on pheasants revealed that mortality was maximum in winter as a high rate of predation occurred during this time (Dumke and Pils 1979). Gates and Hale (1974) studied the reproduction of Ring-necked pheasant in central Wisconsin and found that harvesting operation was mainly responsible for mortality of pheasants. Dumke and Pils (1979) studied the re-nesting dynamics of pheasants in Wisconsin and established that of 31% of the nests were successful and 68% of nests were disturbed. Out of this 69% re-nested but 71% of the second clutches were terminated and 41% of females re-nested and produced 40% of broods. Warner (1981) reviewed the population, ecology and distribution of pheasants in Illinois from 1900-1978. Greater population densities were attributed to high winter cover and more hay and small grain fields. Except for some areas there was a general decline in the population and for management purposes, he recommended the efforts to be directed towards establishment of habitat for nesting foraging and improvement of habitat on agricultural lands. The study in Oregon on the common pheasant (Meyers *et al.* 1988) revealed that survival of the broods was related to different cover types.

1.7.4 Breeding:

The Ring-necked pheasants were polygamous with a harem size of 2.4±0.4 hens (Hills and Robertson 1988b). Same results were obtained from other studies at various places in Ireland (Robertson 1986), Sweden (Goransson 1980) and America (Trautman 1982). Westerkov (1956) found that average number of hens per cock was just over one. Koubek & Kubista (1990) studied the daily activity pattern of lekking pheasants males in Europe and found that peak sexual behavior occurred in the first ten days of April and afterwards their was a distinct decline in May, while in southern Moravia male *P. colchicus* preferred territories that were divided into various activity centers having suitable cover while open fields were avoided. Grahn *et al.* (1993) revealed that the individual territories were divided into various activity centers. Male's spacing before females had initiated a clutch did not differ with male's attractiveness and indicated that female choice might have affected the male's spacing behavior (Grahn *et al.* 1993). Ligon and Zwartjes (1995) observed the role of male plumage of Red Junglefowl in female mate choice and found that though the plumage was not a target of female's attraction but males with larger combs were preferred.

1.7.5 Feeding:

Schwartz and Schwartz (1951) studied the food of an isolated population of Ring-necked pheasant in the Hawaiian Islands. They studied a total of 191 crops and gizzards in which 152 food items were recorded and graded according to their importance. Kopischke and Nelson (1966) in their studies in Minnesota and South Dakota revealed that laying hens consumed about 50 percent more grit by weight as compared to non-laying hens and they could selectively pick calcium and magnesium bearing grit. Hill (1985) studied the feeding ecology and survival of pheasant chicks on arable farmland and found that Arthropods in the diet of chicks were important for their survival. Moreby (1987, 1993) described the methods to identify arthropod fragment in the diet of game bird chicks through diagnostic parts specific to certain groups of arthropods.

1.7.6 Management:

The change in land use patterns due to various reasons adversely affects pheasant population. Robertson *et al.* (1993b) studies the effect of land use in breeding pheasant density and reported that territorial male density was limited by habitat quality. They concluded that new woodland plantations and management could increase the breeding pheasant density remarkably.

1.8 Overview of Pheasant studies in Asia:

Few intensive studies have been done in Asia; mainly in China, Malaysia, Nepal, Vietnam, Cambodia, Myanmar and Pakistan. Oldest records on pheasants come from the accounts of British naturalists and hunters prior to 1950. Hodgson (1846), Jerdon (1864), Hume and Marshall (1879), Blanford (1898) and Osmaston (1935) had written field notes which provide valuable information about the pheasants. The work of Beebe (1918-1922) "A Monograph of Pheasant" is a classic work from which many researchers have benefited (Baker 1930, Bates and Lowther 1952, Ali & Ripley 1987) as it provided immense information on pheasants.

1.8.1 Status surveys:

Pheasant surveys in Pakistan documented the presence of five pheasants species (Mirza *et al.* 1978), while Lelliot (1980-81) conducted surveys in Nepal and recorded Cheer pheasant. The species was found at 2200 – 2400 m altitude in open scrub forest and cliffs at close proximity to human habitations. Duke (1989) used call count method to survey the Western tragopan at four sites in Pakistan Himalayas and gave relative population estimates which were ranging between 28 -195 birds. Baral (2000) reported the status and distribution of eight species of pheasants in Nepal. Tint and Zaw (2000) gave the details of status of pheasants of Myanmar and reported 17 species from the country. Sarker and Sarker (2000) reported the presence of Kalij, Red Junglefowl, Grey peacock pheasant in Bangladesh while Setha and Bunnat (2000) reported Silver pheasant *Lophura nycthemera lewisi*, Siamese fireback *Lophura diardi*, Germain's peacock-pheasant *Polylectron germaini*, Grey Peacock-pheasant

Polyplectron bicalcaratum and Green peafowl *Pavo muticus* from Cambodia and the threats these species are facing there.

1.8.2 Habitat studies

Islam and Crawford (1987) studied the habitat use of Western tragopan and found that the structural components of vegetation influenced the habitat use rather than forest types or plant associations. In a study on the Ecology of Chinese Monal *Lophophorus ihuyssi* Hen Few-qui *et al.* (1988) reported that the species inhabited alpine scrub, sub-alpine and alpine pastures and exposed rocky and cliffy mountain sides. Ding Ping and Zhugo Yang (1990) studied Elliot's pheasant in China and reported that the species occurred between 300 – 1500 m altitude and used shrubby zone in winter and early spring, mixed and coniferous forest in breeding season and high mountain zone in autumn. Severnighaus and Severinghaus (1989) studied the Ecology and behavior of the Mikado pheasant *Syrmaticus mikado* and Swinhoe's pheasant *Lophura swinhoe* in Yshman National Park (Taiwan) and found that Swinhoe's pheasant was found between 1000-2000 m altitude in warm temperate zone in broad-leaved forests with gentle slopes, while Mikado pheasant occurred between 1900- 3800 m altitude range in cold temperate zones in coniferous and mixed forest with steep slopes. Young *et al.* (1991) studied the ecology of Cabot's tragopan *Tragopan coboti* and found that the species used areas with thick undergrowth having a greater percentage of bare ground, proximity to water sources and a gentle slope. *Daphniphyllum macropodum* was important food plant and roosting site for Cabot's tragopan. Bland and Han Lixian (1992) studied Brown-eared pheasant in China and found the species associated with broad-leaved and coniferous mixed forest at 1300- 2200 m altitude with a density of 1/km². McGowan (1994) found that the Malaysian peacock-pheasants were found in clusters and not evenly distributed in their available habitat in Peninsular Malaysia These clusters were located in areas that were away from the river and presence/absence of ground vegetation was prime factor responsible for the display scrapes in the species. Study on the Brown

Eared pheasant found that the species inhabit broad-leaved and coniferous forest between altitudes of 800 -1800 m (Li Xiantao 1995).

1.8.3 Breeding and Nesting:

As study on the nesting ecology of the Cabot's tragopan in China found that the birds in the forest edges nested on trees of *Pinus taiwanensis* and had a clutch size of 2-6 eggs. The nest losses occurred due to predation, inclement weather conditions or collection of eggs by the locals. (Wang & Guang-meri 1989) and maximum nests were destroyed by predation. Liu Xiano Hua *et al*: (1989) studied the Hume's pheasant and observed that the breeding occurred in February to June and nests were made on the ground with fairly dense cover. Chicks were reared exclusively by the females till July and accompanied by the male up to early August, when the brood began to acquire their adult plumage. Zhao Zhengjie (1989) studied the breeding Ecology of the Ring-necked pheasant in China and found that they inhabit low mountain plains with shrubs and grasses with natural secondary Oak forest. Flocking occurred in autumn and winter and the flocks broke-off during summer into groups of one or two birds each. The males marked their territory during the breeding season which lasted from May to July. Nests were on grassy or bushy ground with a clutch size of 10 – 19 eggs. Serveringhaus and Serveringhaus (1989) found that Swinhoe's pheasants were usually solitary but pair or family parties were formed during the breeding season. Li Xiantao (1995) studied the status of the Brown-eared pheasant in China and found the species to be stable with low population density and poor breeding success. High rate of egg loss was attributed to predators and collection by local people.

1.8.4 Diet:

Few studies are available on this aspect of ecology of pheasants. Davison (1981c) studied the food habits of Crested fireback pheasant *Lophura ignita* in Malaysia and reported that birds found in moist areas were having abundant invertebrates in the diet. Lu Xiaoyi (1989) studied the diet composition of Cabot's tragopan and found that the species was primarily vegetarian and the crop content had 95 % dry weight of fruits. Study on

Hume's pheasant (Liu Xiaohua *et al.* 1989) in China found that the bird was a ground forager and its diet was primarily vegetarian. The Ring-necked pheasant in China was found to be mainly vegetarian in food habits (Zhao Zhengjie 1989) and vegetarian food comprised up to 83% of the crop and stomach contents in 42 birds.

1.9 Overview of Pheasants studies in India:

The detailed study of pheasants in India started only in late 80's. Kaùl (1989), Sharma (1990), Iqbal (1992), Ahmed (1994), Yasmin (1995), Khaling (1998), Hussain (2002), Ghose (2003) and Ramesh (2003) conducted detailed studies of some pheasant species in India. However, numerous short-term studies on various aspects of the behavior, ecology and distribution of pheasants have been conducted from time to time.

Most of the pheasants species present in India are distributed in the Himalayas. A state- wise description of the pheasant studies is given below. The number of pheasant present in each state is given in Fig 1.2.

1.9.1 Jammu and Kashmir:

There are seven species of pheasants reported in this state. Lamba *et al.* (1982) did the first short survey in the Kashmir valley and reported the presence of Himalayan Monal and Koklass from the state. Later Qadri *et al.* (1989) conducted status survey on pheasants and reported the presence of four pheasant species from Kashmir valley. The presence of Western trogopan was reported from the Limber valley (Kaul and Quadri 1989). Later Akhtar *et al.* (1994) conducted surveys in the Limber valley and sighted two Western tragopans from the area.

1.9.2 Himachal Pradesh:

The state holds seven species of the pheasants and Himalayan Monal is the state bird. The documentation of the pheasants began with Himachal pradesh jungle project (Gaston *et al.* 1981a). Bland (1987) reported good number of Koklass from Kullu. Gaston and Singh (1980) surveyed the Chail Wildlife Sanctuary for Cheer pheasants and saw 12 individuals on steep grassy

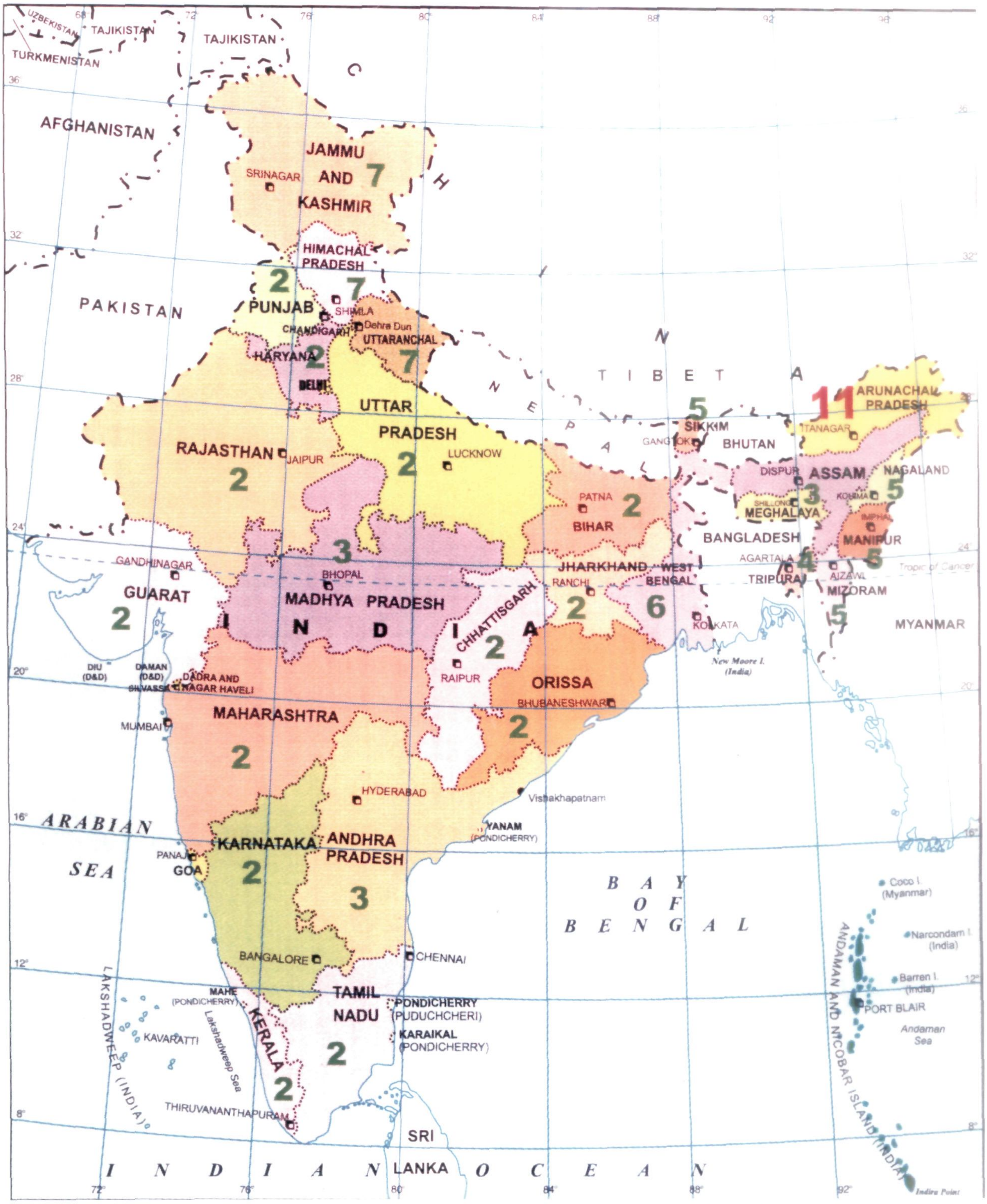


Fig. :- 1.2 Number of pheasant species present in each state of Inida slopes in areas scattered with trees and bushes and counted nine pairs of Cheer through call counts. Gaston *et al.* (1983a) carried out surveys in 1979 and 1980 in the Upper Beas Valley and the adjoining Ravi and Sutlej Valleys. They documented the presence of seven species of pheasants and identified habitat destruction as the most immediate threat to pheasants in the Western Himalayas Gaston *et al.* (1983b) carried out wildlife and habitat surveys in Upper Ravi, Beas and Sutlej catchments and recorded five pheasant species (Cheer pheasant, Monal , Koklass, Kalij and Western tragopan). They also recorded the altitudinal distribution of all five species except Kalij pheasant, which was present in all habitats extending from lower part of the temperate zone to the sub-alpine forest. They also identified hunting and habitat destruction as the main threats to wildlife in the region. Iqbal (1992) studied Kalij pheasant near Shimla and found that it preferred Oak and Cheer pine *Pinus roxburghii* mixed forest and avoided terraced open areas. Pheasant surveys conducted in the upper Beas valley (Pandey 1992) documented the presence of six species of pheasants in the area. Cheer pheasant was confirmed at ten new sites, White-crested kalij pheasant at six sites while Western tragopan, Red junglefowl and Peafowl were recorded at two sites each. Narang (1993) conducted surveys in three districts of Chamba, Shimla and Kinnaur and reported Western tragopan from six localities. The distribution range was found between 2700-3300 m altitudes in the upper half of the temperate belt. Disturbance to the habitat in the form of grazing, collection of forest produce and clearing for cultivation even up to tree line were considered as the major threats to the Western tragopan and other pheasants. Panday (1994) reported a density of 1.5 birds/km^2 in winter at Daranghati Wildlife Sanctuary. Jandrotia *et al.* (1995) conducted surveys of the catchments of river Rave in Chamber district and documented the presence of Cheer, Western dragoman and Himalayan modal in four selected forest areas. Modal was found in all the forests surveyed while Western dragoman was encountered in Sara, Grossman, and Bhatia, while, Cheer was found only at Sara, Bhatia and Tatiana. Kalsi (1998) surveyed four districts and found that Cheer pheasant occupied sites that had a combination of low shrubs which are subjected to regular browsing and cutting. The birds were observed to be associated with tall grass in summer. Jandrotia *et al.* (2000) reported the results of surveys undertaken between 1994 and 1999. Fifteen sites were surveyed in Chamber district between altitudes of 1800- 4500 m and abundance of five species of pheasants was reported using encounter rates and density indices. Himalayan modal, Kolas and Kali were present in all the sites while Western dragoman occurred at 10 sites out of which surprisingly none was under protected area network. Cheer occurred at nine sites. There was a significant decrease of encounter rates of pheasants over the years. The density indices at Sara area were 14.65±0.79 calling groups /km² for kolas, 2.27±1.42 calling groups/km² for Cheer and 3.28±0.48 calling groups /km² for Western dragoman. Ramesh *et al.* (2000 a, b) studied the distribution pattern of Western dragoman, Kolas, Modal and Cheer at Great Himalayan National park. They found that large population of pheasants was present in the Trithan and Jiwa valley and their distribution was mainly influenced by altitude, slope and aspect. Western tragopan and koklass occured between 2250 - 2980 m altitudes in summer and 1890 - 2700 m in winter, while monal occurred in between 2620 - 3350 m altitudes in summer and 2000 - 2800 m in winter as well as there was a decline of 45%, 18% and 17% of Monal, Koklass and Western tragopan populations respectively, over two years. The later study showed group size of 1-11, 1-3, and 1-2 birds for Monal, Koklass and Western tragopan, respectively. Monal was seen in groups all over the year while Koklass and Western tragopan were seen either solitarily or in pairs through out the year. Khan *et al.* (2000) measured the population status of Western tragopan using two methods. They surveyed 14 sites in the state and encountered 47 birds while 43 birds were heard. The highest numbers of tragopans were heard at seven sites in the area of Specka forests. Shah and Kalsi (2000) studied the habitat use of Cheer and Kalij pheasant at Majatha-Harsang Wildlife Sanctuary and found that the Cheer preferred grasslands and scrub habitats while Kalij did not show any preference for a particular habitats but uses the habitat in proportion to their availability.

1.9.3 Haryana:

There are two species of the pheasants found in the state i.e. Red junglefowl and Indian peafowl. Only one study on the pheasant has been under taken in the state. Kalsi (1992) studied the habitat use of Red junglefowl at Kalesar forest reserve and found that the species preferred mixed forest with cultivation rather than Sal *Shorea robusta* and mixed forest.

1.9.4 Uttaranchal :

This newly formed state was a part of Uttar pradesh. There are seven species of pheasants reported from the state. Collias and Collias (1967) studied the vocalization of Red junglefowl and found that crowing was used by the dominant male to advertise territorial rights and dominance. Their study suggested that the breeding behavior and vocal repertoire of the Red junglefowl in nature were similar to those of the domestic fowl and considered the Red Junglefowl to be its ancestor. Young and Kaul (1987) conducted surveys in Kumaon Himalaya and documented status and habitat of five pheasant species i.e. Kalij, Koklass, Monal, Satyr trogopan and Cheer pheasant from the area. Young *et al.* (1987) studied the calling behavior of Cheer pheasant in Almora and documented five types of calls. While a study on Monal at Kedarnath Wildlife Sanctuary revealed that they preferred temperate, sub-alpine coniferous forest or scrub and alpine forest during different seasons (Bisht *et al.* 1989). Chandola-Saklani *et al.* (1989) studied some of the behavioral traits and seasonal movements of White-crested kalij at three different sites in Garhwal Himalayas. They found that there was a significant negative correlation between emergence and day length and a positive correlation between return of the birds and day length. As compared to males, female birds showed greater foraging activity, which declined during the breeding season. Sathyakumar *et al.* (1992) studied the abundance and habitat use of Kalij and Monal pheasant in Kedarnath WLS. They calculated the density of 16-17 pair/km^2 and 10-16 pair/km^2 for Kalij and monal, respectively. Kalij occurred in temperate forest between 1600- 2000 m altitudes on north, north-eastern and eastern slopes while monal occurred in sub-alpine habitats between 2600-3300 m altitudes in south, south-eastern and south-western slopes. The major threats faced by pheasant populations were poaching, habitat destruction by large scale grazing, bamboo collection and forest fires. Sharma and Chandola-Saklani (1993) monitored nine different population of White-crested kalij in Garhwal Himalayas and found that breeding occurred between March-July with some variations in successive years. Ahmad and Masavi (1992) estimated a density of 5 birds/km^2 of the White-crested kalij at Ranikhet and most of the birds were observed in scrub vegetation. Iqbal (1992) studied the habitat use of White-crested kalij in Kamoun Himalaya and observed that the species preferred grassy openings and scrub. Kumar *et al.* (1997) reported that monal at Kadernath Wildlife Sanctuary preferred dense wooded areas with thick litter cover during autumn and winter. It occurred near cliffs and open areas during spring. Hussain *et al.* (1997) studied the ecological aspects of five pheasant species i.e. Satyr, Kalij, Koklas, Monal and Cheer pheasant in kumaon Himalayas. These species preferred different habitats in different seasons while three factors namely the altitude, shrub and herb layer played major role in their distribution. They also identified tree felling and indiscriminate lopping as the major threats to the pheasant's populations. Hussain *et al.* (2001) studied some aspects of ecology of Kalij and Koklass in Kumaon Himalaya and found altitude to be the main discriminating factor in the distribution of these species. Kalij abundance was positively correlated with shrub diversity, herb density and live stock population while Koklass abundance was positively correlated with altitude, grass richness, herb diversity and herb richness.

1.9.5 Uttar Pradesh:

There are two species of the pheasants reported from the state. Yasmin and Yahya (1995) studied the roosting behaviour of the Blue peafowl in Aligarh district. They found that tree height, girth and height of first branch were responsible for roost site selection and Dalbergia *sisso* was the most preferred tree species for roosting. Javed and Rahmani (2000) studied the flocking and habitat use of Red junglefowl in the Dudwa National Park and reported that 80 % of birds were solitary and no significant difference was found in the flock size in winter and summer. The species preferred mixed forest and avoided Teak *Tectona grandis* forests while Sal forests were used in proportion to their availability.

1.9.6 North - Eastern states:

There are thirteen species of pheasants reported from north-eastern states which include the states of West Bengal, Sikkim, Assam, Arunachal Pradesh, Nagaland, Manipur, Tripura, Mizoram and Meghalaya. This part of the country is still biologically unexplored and not many pheasant studies have been conducted in this area.

Pheasant studies started in early 1990 in North east India. Katti *et al* (1992) carried out study in arunchal Pradesh. Kumar and Singh (1999, 2000) studied the two species of monal, the Himalayan Monal and Sclater's monal in Arunchal pradesh and mapped their distribution pattern in the state. They also found a probable new taxon of Monal pheasant which had a distinctly different tail pattern as compared to the other two species. In West Bengal, Khaling (1998), Khaling *et al.* (1998) and Khaling *et al.* (2002) conducted surveys on Satyr tragopan at the Singhalila National Park, Darjeeling district using call counts. They found the mean density of 6.19 calling groups per km^2. Ghose (1997) and Ghose *et al.* (2000) studied the distribution of Blyth's tragopan and its habitat use at Blue Mountain National Park (BMNP) in Mizoram. In BMNP, only 15% of the total area supported this species. Ghose and Thanga (1998) surveyed distribution and habitat use pattern of Satyr Tragopan at Maenam Wildlife Sanctuary in Sikkim and of Temminck's tragopan in West Siang district of Arunachal Pradesh. Kaul and Ahmed (1993) studied pheasant distribution in the state of Arunachal Pradesh and found occurrence of Blyth's tragopan at the Mehao Wildlife Sanctuary. Later Kaul *et al.* (1996) mapped the distribution of pheasants in three protected areas within the state of Mizoram. Singh (1994) also did short-term studies on general avifauna in Arunachal Pradesh and mapped distribution of certain pheasant species within this state. Choudhury (2000, 2001) did substantial work on pheasants in Northeast India through a series of short term surveys and has updated distribution pattern of different pheasant species in this region.

1.9.7 South India:

There are only two species of pheasant found in south India i.e. Grey junglefowl and Indian Peafowl. Murali and Johnsingh (1978) studied the ecology and behaviour of Indian peafowl at Injar. Zachharias (1997) studied the Grey jungle fowl at Periyar National Park. Sathyanarayana *et al.*(2000) studied Grey junglefowl at Theni forest division in the Western Ghats and reported an overall encounter rate of 0.96 birds/km^2 and a sex ratio of 1.78:1 (male : female). Sathyanarayan & Ganaesan (2000) studied the diet of Indian peafowl at Tamil Nadu and found that 60% of the faecal matter consisted of plants parts while only 11% consisted of animal fragments. Paddy was most prevalent grain taken while family Formicidae was mostly taken as an animal food.

1.10 Overview of Cheer pheasant studies.

Hardwicke (1827) described the Cheer pheasant for the first time. Most of the earliest records were in the form of reports by the sportsmen and naturalists. Although, these reports were lacking in relevant scientific information but gave important information about status, distribution and habits of these birds. Recent publication on the species mainly deals with status and distribution and there is only one intensive study (Kaul 1989) has been conducted so far.

The first reliable account of the Cheer pheasant was in the Transactions of the London Linnaean Society (1877) by Major General Hardwicke which gave the description of the bird and also reported that the locals call it by name 'Cheer'. Jerdon (1864) observed its morphology, habitat preferences, vocalization, food and breeding behaviour. About the distribution of the species he described that the bird was found in N. W. Himalayas extending up to Nepal. Hume and Marshall (1879) thought that the bird always had patchy distribution though common in Kumaon, Gadwal and Chamba.

Beebe's account of the Cheer pheasant in his "Monograph of the Pheasants" (1918-1922) gave detailed description of wild cheer. He proposed that the range of the cheer extended from Chamba through Garwal and Kumaon, where it was quite common up to the west bank of the Kali Gandaki river in Nepal.

Osmaston (1935) belived cheer to be fairly common in the hills beyond Chakrata (Uttarkashi, Uttaranchal) between 500 and 900 feet. Baker (1935) considered that cheer have a wide range and considered that the North Western Frontier was its western most limit. Bates and Lowther (1952) thought that the bird never occurred in the vale of Kashmir. Ali and Ripley (1987) observed that they were well distributed from Hazara in N.W. Pakistan through Kashmir, Himachal, Garhwal and Kumaon to west central Nepal and also described their general behaviour.

Robertson (1970) reported the presence of the Cheer pheasant in the Neelum valley and Hazara in Pakistan and expressed the fear that it was on the verge of extinction.

Delacour (1977) in his classical work on the 'Pheasants of the World' complied the information of the earlier workers with his observations of the captive birds. With the disappearance of cheer from Margalla Hills in Islamabad, Pakistan in 1976, a cheer reintroduction project was initiated by the World Pheasant Association and W. W. F. - Pakistan. A survey was subsequently conducted to identify areas suitable for the rearing and release of birds (Severinghaus 1979). Mirza *et al.* (1978) reported the presence of Cheer from Machiara areas of Pakistan.

Gaston and Singh (1980) surveyed Cheer pheasant in the Chail Wildlife Sanctuary, Himachal Pradesh, India and estimated about 40 pairs of cheer with a density of 6 pair/km^2.

During the Himachal Pradesh Wildlife Project, extensive surveys were made in the Himachal pradesh for pheasant studies (Gaston *et al.* 1981). They found cheer at five sites besides Gaston's records of four other sites and had convincing reports of the species from two other places. They concluded that cheer is well distributed in Himachal Pradesh and assumed that the population in the state to be over one thousand pairs.

Lelliot (1982) surveyed the Athhazar Parbat area in the west-central Nepal near the Kali Gandaki river, the supposed eastern limit of the cheer range. He saw cheer at only one site but locals claimed that it is common in the area. Another survey by Lelliott (1986) near Dhorpatan in west-central Nepal yielded positive results about the presence of the cheer population in good numbers. He heard a total of 31 cheer and estimated the total number of cheer between 50-100 birds. He also found that most of areas holding cheer were subjected to considerable disturbance but thought that birds are used to such disturbances.

In continuation of the Himachal Pradesh Wildlife project, (Garson 1983) repeated the survey at Chail Wildlife Sanctuary besides making surveys at other sites. He reported a 50% decline in cheer population at Chail but found a new population in Majathal Wildlife Sanctuary and sites holding substantial cheer population three in upper Beas catchment in Himachal Pradesh.

Ridley and Islam (1986) gave the details of the progress of the cheer reintroduction in Margalla Hills in Pakistan and identified reasons for the failure of the project and gave suggestions for making the project successful. Rasool (1984) reported on the behaviour the Cheer from Mukhteshwar.

Young *et al.* (1987) assessed the cheer reintroduction at Margalla Hills and said that they achieved comparatively higher hatching rates. However, the released birds did not survive, they recommended further release of birds in the area.

Cheer pheasant is distributed from Kashmir through Garhwal to Kumaon Himalayas in India. Cheer pheasant *Catreus wallichii* is predominantly a bird of grasslands and scrublands dissected with wooded ravines with scrub. Cheer has an altitudinal range between 1200 – 3500 m and has a strong affinity for the early successional habitats which are maintained frequently by human intervention (Kaul 1989, Kalsi 1998, Fuller and Garson 2000).

The main threat the bird is facing is due to habitat degradation, over hunting and conversion of the land to agriculture (Fuller and Garson 2000). Most of the studies have revealed that the populations are small at each site (< 15 birds), making them vulnerable to local extinction (Kaul 1989, Sharma 1992, Fuller and Garson 2000). The bird has been put under category C_{2a} that it is counting to decline in numbers and is affected severely by fragmentation (Collar *et al.* 1994) and considered Vulnerable (Mace and Lande 1991, Fuller and Garson 2000), Cheer is schedule I species under Wildlife Protection Act (1972) and Appendix I of CITES.

Cheer has a very patchy distribution which is due to its specialized habitat requirements, thus further study leading to sympathetic habitat management for the Cheer is much-needed (McGowan & Garson 1995).

Chapter 2

Study Area

2.1 Introduction

The Himalayas are young, complex chain of mountains, well known for their floral and faunal diversity, aesthetic and geo-hydrological cultural values. The Himalayas were best described in the Sanskrit proverb "*A hundred divine epochs would not suffice to describe all the marvels of the Himalaya* ". The mountains of Himalayas are having northwest to southeast orientation. The main range of the Himalayas comprises of three zones. The outer Himalayas which are up to a altitudinal elevation of 1500 m above sea level, the middle Himalayas having an altitudinal range of 5000 m above sea level and the Greater Himalayas, the highest mountain chain in the world exceeds the altitudinal range of 8800 m above sea level (Wadia 1966). Himalayas have originated as a result of tectonic movements of continental plates and are believed to be still growing. The formation of the Himalayas resulted in new barriers and corridors which influenced the dispersal of flora and fauna. Being at the meeting point of two bio-geographical regions i.e. the Oriental and the Palaearctic (Mani 1974), the Himalayas provided various habitats that were occupied by many primitive as well as newly evolved species. The temporal and spatial variation in the physical conditions have also resulted in interesting patterns of phytogeography characterized by the high degree of endemism and localized distribution of certain species (Mani 1974, Singh and Singh 1987).

Himalayas are the one of the richest bio-geographical zones in India and cover an area of about 42,200 km^2 which is nearly 15% of the India's land surface. The location, climate, and topography of the Himalayas have endowed it with rich and diverse life forms. The Himalayan region is inhabited by about 51 million people which is 6% of the Indian population (Anon 1993). The human population in the area has increased over 170% since 1951 (Moddie 1981). Alterations in the cropping patterns and landscape changes due to development have led to the shrinkage of much prime wildlife habitats. The existing and proposed network of Protected Areas (PAs) in the Indian Himalayan region covers an area of 9.2% of the total range (Rodgers and Panwar 1988). About 65% of these PAs are located between 2000m and 4000m which are densely populated.

Biogeographically, the Himalayas are divisible into four provinces viz.. Northwestern, Western, Central and Eastern (Rodgers and Panwar 1988), each of which has characteristic by distinctive flora and fauna. In west, River Sutlej is taken as the boundary between the western Himalayas and northwestern Himalayas (Mani 1974).

The state of Himachal Pradesh has an elevation, ranging from 300 to over 6000 m, and it accounts 17% of the area in the northwestern Himalayas. Bio-graphically, the state can be divided into three distinct regions - The Trans-Himalayas, which includes the cold deserts of northern Lahul and Spiti districts, the Greater Himalayas, High and middle mountains ranges covering most of the state and the Semi Arid zone, comprising the hot and dry foot hills in the south (Rodgers and Panwar 1988).

The sub-tropical and warm temperate regions of the Western and North-Western Himalayas are quite vulnerable to anthropogenic pressures such as habitation, cultivation, urban-industrial development and intensive biomass extraction. Most of the PA in this region are small (< 100 Km^2) in size, highly fragmented and interspersed with human habitations (Rogers & Pawar 1988). Such PAs are further threatened due to rapid development activities such as river valley projects for generating electricity and diversion of water for irrigation and other purposes. As a result natural ecosystems and wildlife habitats are shrinking rapidly. Such a scenario is prevalent throughout the region including Himachal Pradesh (HP) where the PAs managers are faced with conflicting demands of development, developments projects and pressing conservation needs. Most of the PAs lack the baseline ecological information and well-organized management plans.

2.2 Himachal Pradesh

Himachal Pradesh has a geographic area of 5.57 million hectares. It is situated in the north west of India in the Himalayan ranges between lat. 30° 22' and 33° 13' N and long. 75° 36' and 79° 02' E. (Singh *et al.*, 1990). The state has its borders with Jammu and Kashmir on the north, Punjab on the west and southwest, Haryana on the south and Uttaranchal on the southeast. The state is mountainous with altitude ranging between 460 to 6600 m. The Himachal Pradesh is drained by number of snowfed perennial rivers. The Chenab, the Ravi, the Beas, the Sutlej and Yamuna. Forest in the Himachal Pradesh constitutes the biggest land use. The land use is given in Table 2.1. The average rainfall in the state is 1800 m. The mean annual temperature ranges between 20° to 22.5 ° centre grade

Table 2.1 Land use statistics of the state of Himachal Pradesh

S. No.	Land Use	Area in '000 ha	Percentage
	Total geographical area	19,602	
1	Reporting area for land utilization	18,813	100
2	Forests	1,861	9.89
3	Not available for cultivation	3,742	19.89
4	Permenent pasture other grazing lands	849	4.51
5	Land under misc. tree crops and groves	4	0.02
6	Culturable wasteland	1,974	10.49
7	Fallow land other than current fallow	24	0.13
8	Current fallow	759	4.04
9	Net area sown	9,600	51.03

2.2.1 Forest Resources:

The recorded forest area in Himachal Pradesh of the state is 3.54 million hectare, which constitutes 63.60% of the geographic area. By Legal status, Reserved Forest constitutes 5.35%, Protected Forest 88.89% and Unclassed forest 5.76%. (Forest Survey of India FSI 2000).

There are six forest types in the state-

i) Tropical Dry Deciduous
ii) Sub-tropical Pine
iii) Sub-tropical Dry Evergreen
iv) Himalayan Moist Temperate
v) Himalayan Dry Temperate
vi) Sub-alpine and Alpine Forests

2.2.2 Protected Areas:

The Protected Areas network comprises of two National Parks and 32 Wildlife Sanctuaries, covering an area of 0.14 million hectare and 0.57 million hectare respectively. The total PA is 0.71 million hectare, which constitute about 12.87 % of the geographical area of the state (FSI 2000).

2.2.3 Forest in Villages:

There are 1997 villages in the state of which 5994 (38%) have forest as a recorded land use. The forest area in these villages is about one million hectare. The total population of these villages is 1.5 million. The villages having less than 100 hectares, between 100 – 500 hectares and more then 500 hectares forest area in each village constitute 76%, 21% and 3% of the total villages, respectively which is provided in Table (2.2).

Table 2.2 Forest land use in villages of Himachal Pradesh

	Forest Area	Number of villages	Total forest area (ha)	Population
1	Less than 100 ha	4,850	175,236	1,208,549
2	100- 500 ha	1,051	308,212	291,503
3	More than 500 ha	93	508,196	26,295
	Total	5,994	991,644	1,526,347

2.2.4 Forest cover:

The forest cover of the state, based on the satellite data of October-December, 1998, is 13,082 sq. km, which constitutes 23.50% of the geographic area. Dense forest accounts for 9,120 sq. km and open forest 3,962 sq. km. The forest cover is shown Fig 2.1. A net increase of 561 sq. km in the forest cover has been observed in the present assessment compared to the preceding assessment. The difference between the data periods of the two assessments is about three years (FSI 2000).

The change matrix, Table 2.3 reveals that there has been overall decrease of 440 sq. km. of dense forest. This result of conversion of 640 sq. km. of dense forest to open forest and 33 sq. km. to non forest and 92 sq. km. of open forest, 42 sq. km. of scrub and 99 sq. km. of non forest to dense forest (FSI 2000).

The increase of 1,001 sq. km. of open forest is on account of conversion of 92 sq. km. to non forest. The increase is also associated with conversion of 640 sq. km. of dense forest, 253 sq. km. of scrub and 205 sq. km. of non forest to open forest (FSI 2000).

The increase of forest cover is due to inclusion of large scale block plantations of Pine *Pinus spp.*, Khair *Acacia catechu*, Deodar *Cedrus deodara* and Robinia *Robinia spp.* taken during 1989-93 (FSI 2000).

Table 2.3 Forest cover change matrix of Himachal Pradesh

1997 Assessment (Data Oct. 94 & Nov. 95)	**1999 Assessment (Data Oct. – Dec. 98)**				
	Dense Pine	**Open Pine**	**Scrub**	**Non-forest**	**Sq. km, Total 1997**
Dense Pine	8,887	640	0	33	9,560
Open Pine	92	2,864	0	5	2961
Scrub	42	253	558	972	1,825
Non-forest	99	205	8	41,015	41,327
Total 1999	9,120	3,962	566	42,025	55,673
Net Change	**- 440**	**+ 1001**	**- 1259**	**+ 698**	

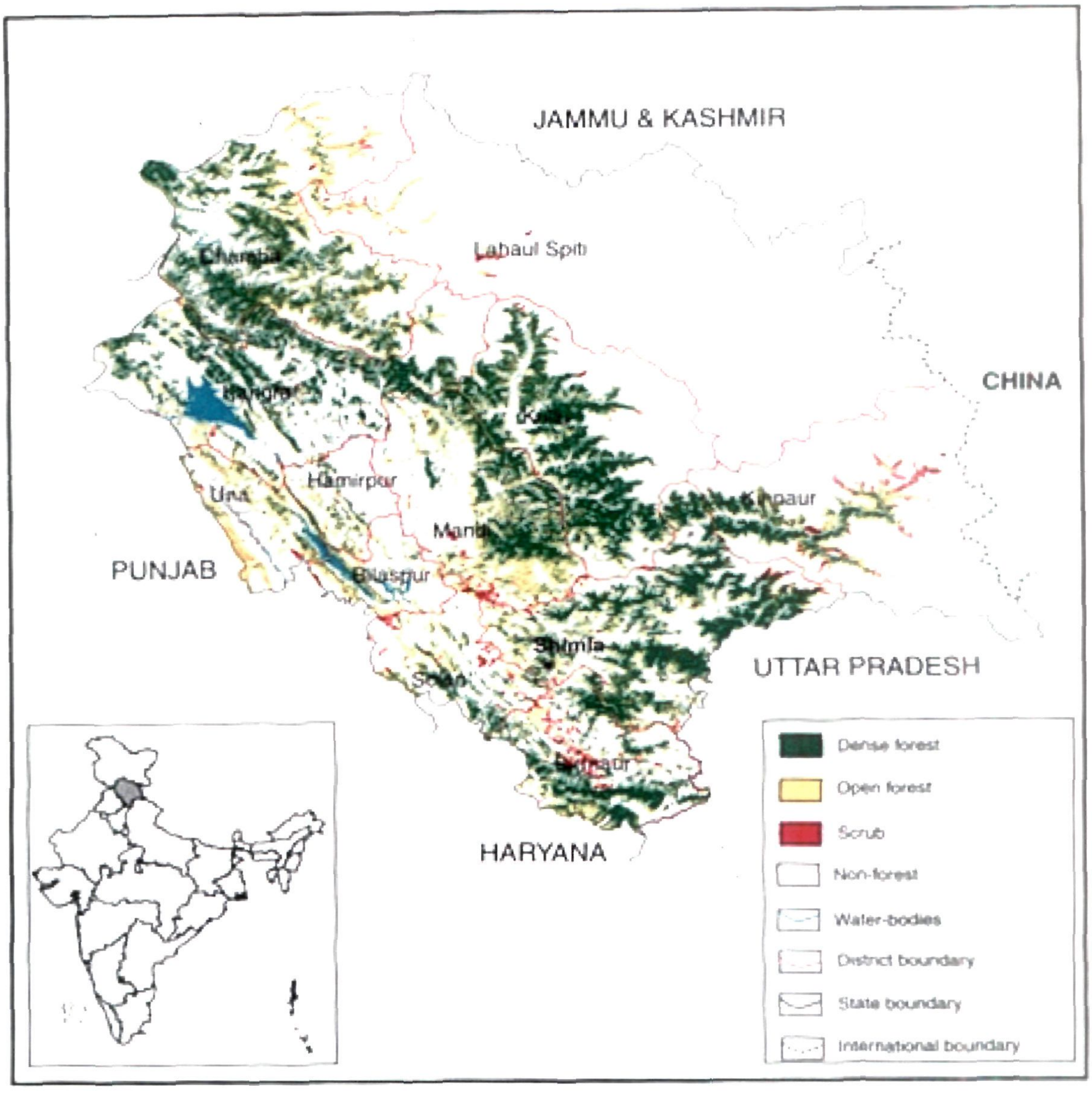


Figure 2.1 Forest cover map of Himachal Pradesh.

2.3 Majathal Harsang Wildlife Sanctuary

2.3.1 Administrative:

The 39 km^2 Majathal-Harsang Wildlife Sanctuary (76° 15' to 77° 5' E and 31° 15' to 31° 18' N) in Himachal Pradesh lies to northwest of Shimla in the catchment of River Sutlej (Fig 2.2). Situated in the districts of Shimla and Solan, the sanctuary is administered under Chandi Range, Shimla Wildlife Division. The sanctuary is divided into three admistrative blocks (beats) i.e. Kangri, Chandi and Harsang.The area was declared a Sanctuary in 1962 and has been re-notified in 1974 by the Government of Himachal Pradesh Notification number 5-11/ 70 SF dated 27-3-74.

2.3.2 Physical:

The sanctuary is situated in the Middle Himalaya, and has hilly terrain with an altitude ranging from 575 m to 2050 m asl. The area is marked with limestone deposits belonging to the Basantpur formation of the Shali-Shimla groups. Other rocks of this succession are shale, siltstone, dolomite and purple and white quartzite (Kumar 1985). Soils of the area are immature, of variable depth and deficient in organic matter (Shagotar 1977).

2.3.3 Boundaries:

The Sutlej river forms the north-eastern boundary of the sanctuary while Senj *Khad*, (perennial stream) demarcates its eastern boundary. On the south Suragdwari and Harsang *Dhar* (ridge) form the natural boundary. Intensive studies on the Cheer pheasant were carried in Majathal (Figure 2.2).

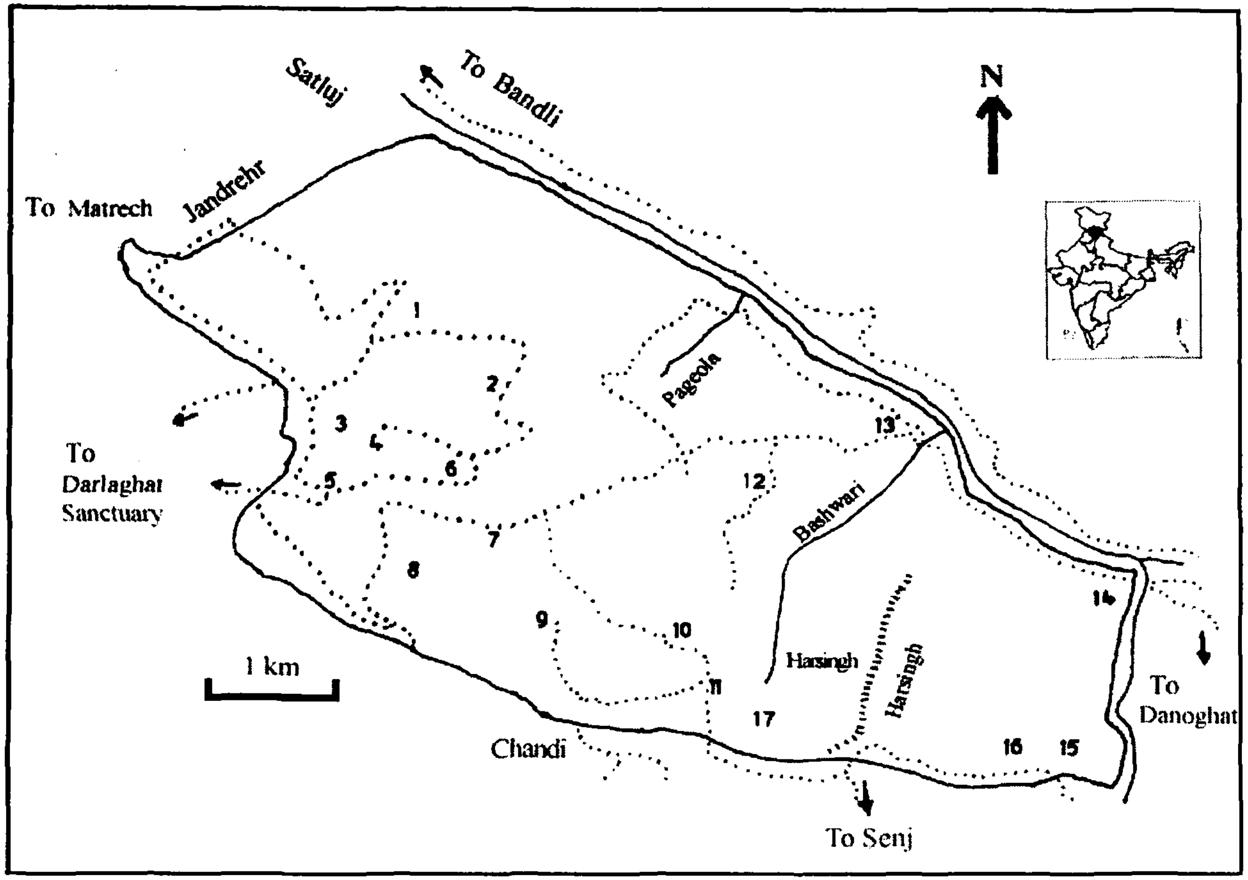
2.3.4 Distribution of water resources:

The sanctuary is distributed with nallas and streams. There are four perennial streams and several ephemeral streams as well as four sprigs.

2.3.5 Biogeography:

The Majathal Harsang Wildlife Sanctuary lies in bio-geographical zone (2c) of according the classification (Roger & Panwar 1988).

Figure 2.2 Map of Majathal-Harsang Wildlife Sanctuary



Villages: 1- Sahra, 2- Taneri, 3- Thrao, 4- Chaloni, 5- Sohra, 6- Pariab, 7- Pajaura, 8- Khaili, 9- Bambeil, 10- Sirali, 11- Pao, 12 – Neori, 13- Kiari, 14- Mindraj, 15- Kot, 16- Darwa, 17- Kiartu

2.3.6 Vegetation:

Himalayan Chir pine *Pinus roxburghii* (9/ CI b) and ban oak *Quercus lecotrichophora* forests (12/CI a) (Champion & Seth 1968) form the major vegetation types. Chir pine community was usually open with thin canopy cover, whereas Ban oak formed a closed canopy. The Chir pine stands were found on the all the aspects while oak stands were restricted to the moist pockets. These stands were also found in narrow vertical strips along nullahs and gullies. At altitude below 1600 m asl, composition of these nullah forests became mixed in nature with little oak. Below 1600 m asl on the drier aspects (E, S, SE), Chir pine was replaced by subtropical Euphorbia scrub (9/CI/DS2) (Champion & Seth 1968) which is dominated by *Euphorbia royleana, Woodfordia fruticosa, Dodoenea viscosa* association. Above 1600 m asl, on the S, SE and SW aspects open rocky Euphorbia scrub and grassland occur along with the Chir pine stands. In the intensive study area, seven types of habitat categories were identified (Chapter 5).

2.3.7 Climate:

The study area has sub-tropical monsoon climate with three distinct seasons.

Winter: November to February (March)

Summer: (March) April to June.

Monsoon (Rainy): July to September (October).

The mean temperature in summer varied from 18.99 to 28.08° C while in monsoon it varied between 18.18 to 25.25° C and winter mean temperatures varied between 8.59 to 17.52° C (Fig 2.3). The mean rainfall over the study period was 268.91 mm while it varied from 0 – 1050.33 mm (Fig 2.4). The relative humidity varied from 28.9 % to 85.1 % (Fig 2.5). Frost in winters and hail in winter and summers was rare. Snowfall was rare, but there were some snowfalls during the study period.

Fig 2.3 Mean temperature at Majathal-Harsang Wildlife Sanctuary during the study period.

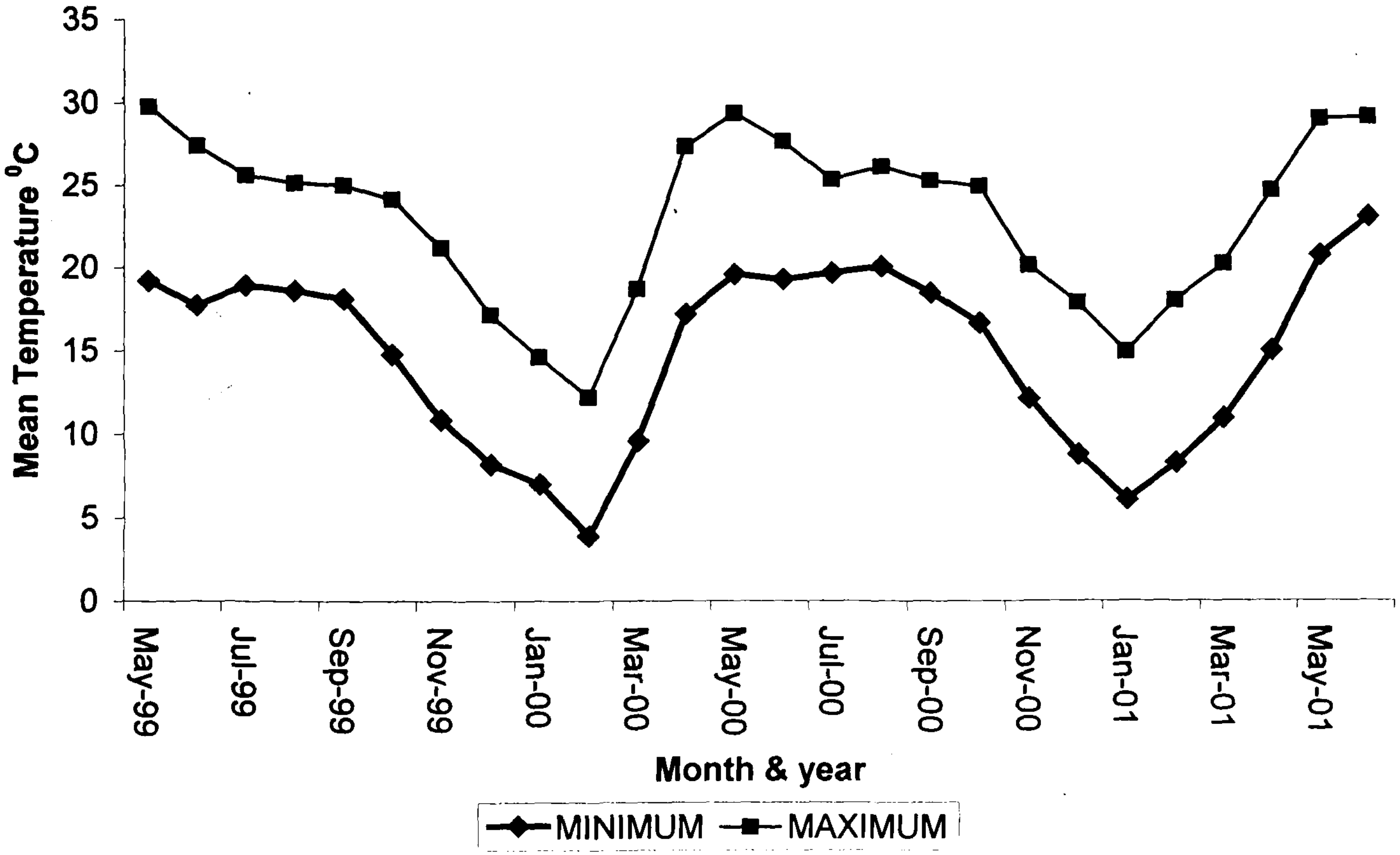


Fig 2. 4 Mean rainfall at Majathal-Harsang Wildlife Sanctuary during the study period.

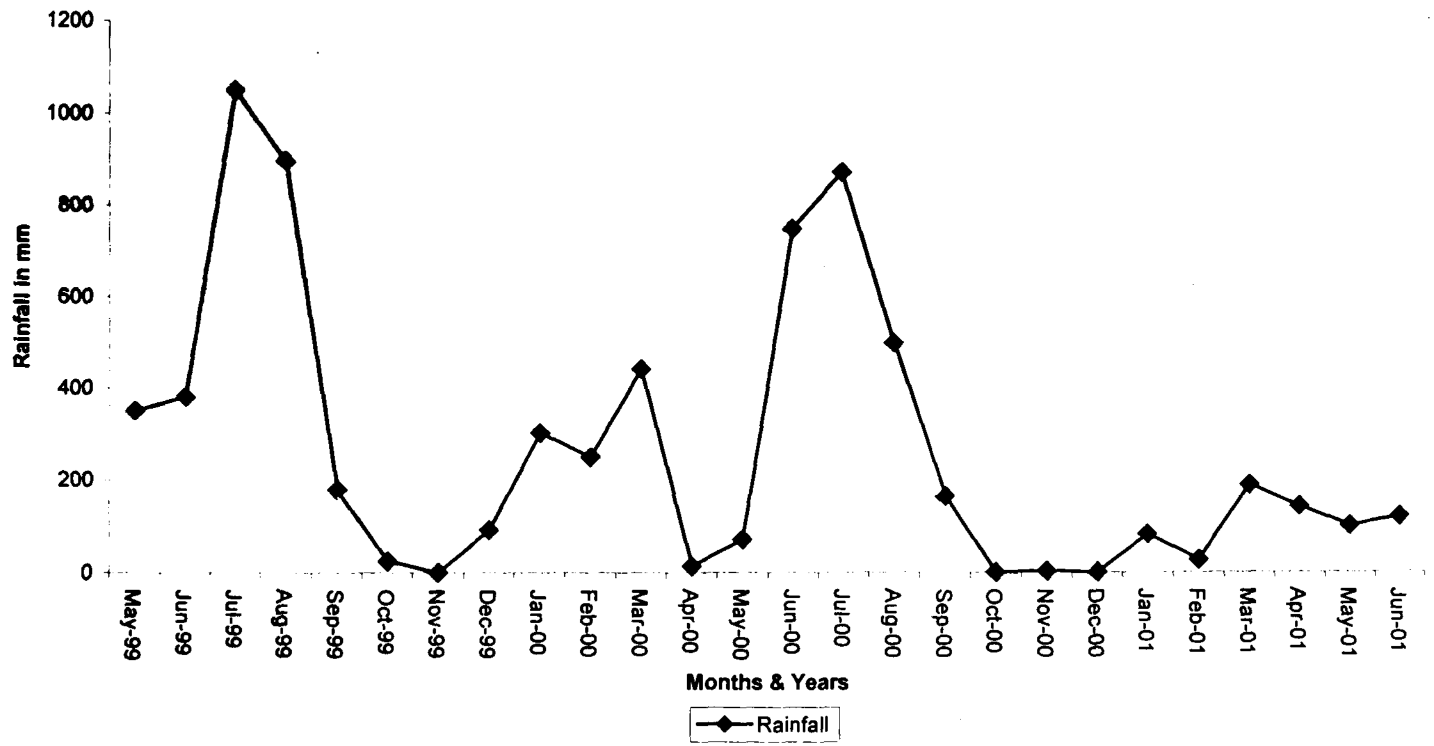
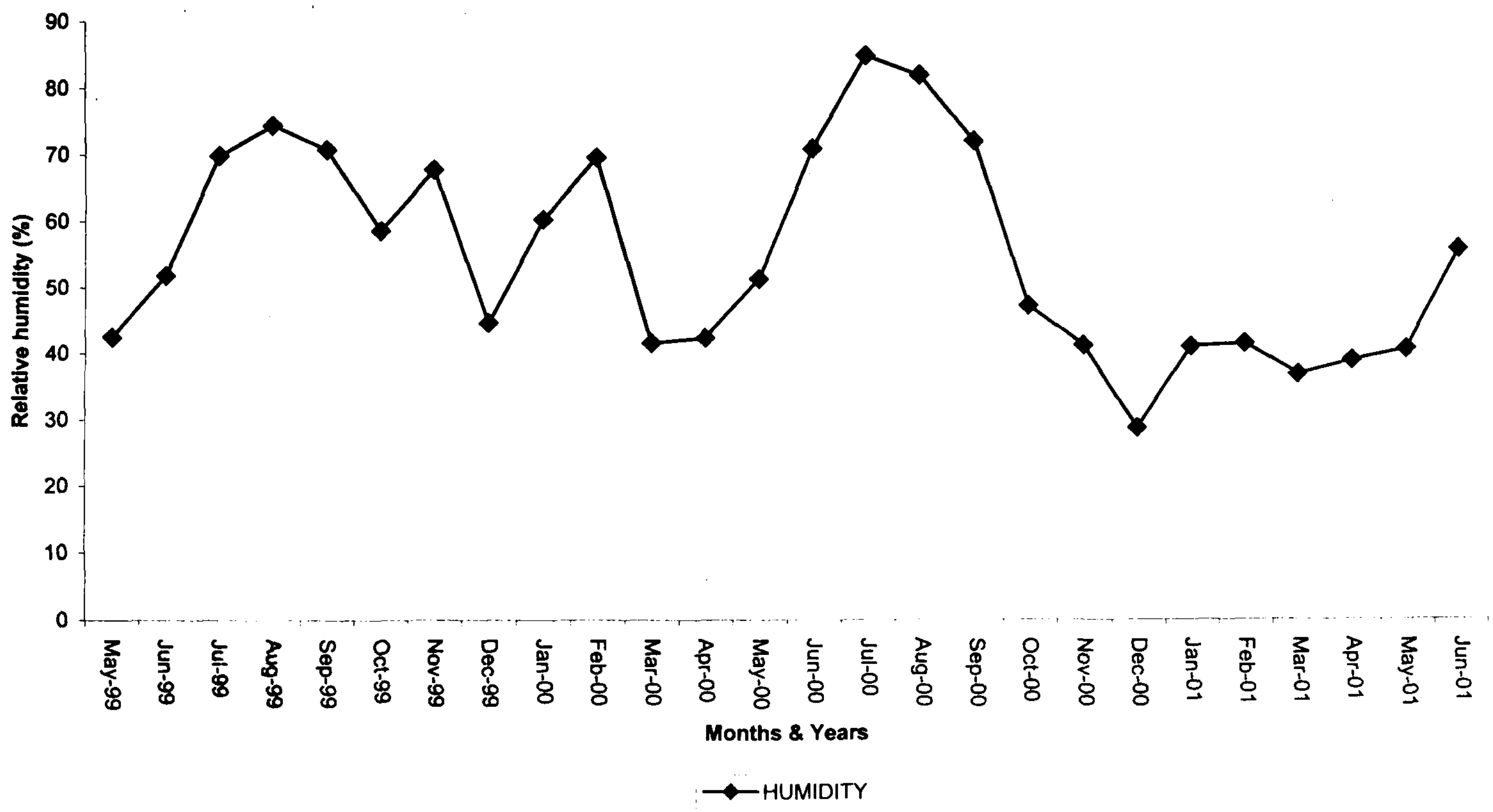


Fig 2.5 Mean Humidity at Majathal-Harsang Wildlife Sanctuary during the study period



2.3.8 Fauna:

The sanctuary holds good populations of Goral *Nemorhaedus goral* (Mishra 1993). The other two ungulate species found were Barking deer *Muntiacus muntjac*, Sambar *Cervus unicolor* and Wild pig *Sus scrofa*. The Sambar and Wild pig were rare. There were two species of primates in the sanctuary- Rhesus macaque *Macaca mullatta* and Common langur *Presbytis entellus*. The mammalian predators Lepoard *Panthera pardus* and Himalayan Black bear *Selenarctos thibetanus* which are found in the area. Himalayan yellow-throated marten *Martes flavigula*, Common palm civet *Paradoxurus hermaphroditus* and Himalayan palm civet *Paguma larvata* were found in the sanctuary. The other mammals included Jackal *Canis aureus*, Jungle cat *Felis chaus*. Porcupine *Hystrix indica* and Rufous-tailed hare *Lepus nigricollis ruficautus* are fairly common.There were seven species of galliformes reported from the area (Mishra 1999). Besides Cheer pheasant, the other pheasant species found were White crested Kalij, which were found in good numbers, Red Junglefowl and Indian peafowl were found mainly distributed in the lower elevations. During the study period no koklass were sighted or heard. However (Mishra 1999) reported koklass from the area. The Red junglefowl and Indian peafowl were found low in numbers in the sanctuary. Black francolin *Francolinuis francolinuis* was the most common francolin found in the sanctuary. The other galliformes were Grey francolin *Francolinuis poidiecerianus* and Chukor *Alectoris chukar*. in the lower elevations.

2.3.9 Local people and Land-use practices:

A good number of villages were located inside as well as on the periphery of the sanctuary. There were 17 revenue villages inside the sanctuary (Chauhan 1994). There were over 20 villages located within 5-10 kms of the southern boundary. Cultivation and livestock rearing were the main occupation of the villagers who have rights to graze, collect fodder, timber, were the main occupation of the villagers who have rights to graze, collect fodder, timber, fuel wood and minor forest produce in the sanctuary (Shagoter 1977). Wheat and Maize were the main crops in winter and monsoon seasons, respectively, while rice was grow at lower altitudes near perennial streams. Human-wild animal conflicts were the main problem here. Leopards frequently killed livestock and Black Bear, Barking deer, Goral, Porcupine and Rufous-tailed hare cause considerable damage to crops. Three cases of the Black bear attacks on human were reported so far.

During winters, *Gaddis* (pastorals) arrived from the higher reaches of Rampur and Kullu districts along with their goat and sheep during December to April. They stayed for some time in the sanctuary. A few *Gujjar* families also brought buffaloes for grazing inside the sanctuary during winter.

There were two water lifting schemes in the sanctuary which provided water to good number villages in and around the sanctuary.

Poaching was common in the area. There were 40 gun licence holders inside and outside the sanctuary. Rifle shooting also takes place, with poachers coming from distant areas. The sanctuary is understaffed with only three unarmed beat guards. Against all odds the sanctuary holds one of the best populations of the Cheer pheasants in the wild (Garson 1983, Kalsi 1998).

According to the Government records of 1980's the land use classes in the area are in Table 2.4.

Table 2.4 Land use classes of Majathal-Harsang Wildlife Sanctuary

	Land use	**Area in ha**
1	Demarcated protected forests	2661.60
2	Wasteland	44.87
3	Pastureland	681.70
4	Grassland	222.43
5	Habitation and cultivation	328.26

Fresh assessment of the above area land use classes have not been carried out. It is likely that the area under habitations and cultivation has increased considerable since 1980s.

Chapter 3

Status and Abundance

3.1 Introduction

Mapping of species distribution is of fundamental importance to our understanding of biodiversity patterns and is an applied tool for conservation managers (Miller 1994). The stepping stone for any conservation strategy involves understanding the status of the species (Margules 1989, Miller 1994). Status is determined by the distribution and abundance of species, and the rate at which these change occur over time. At present we have information about the distribution and abundance of pheasant species such as Satyr tragopan, Western tragopan, Koklass, Monal, Cheer pheasant and kalij. However, little information is available on the rate of change in the populations of these pheasants over a period of time (Khaling *et al.* 1998, Ramesh *et al.* 1999, Khan *et al.* 1999).

There are 51 species of pheasants recorded so far, out of which 40 species are threatened with extinction (Fulller and Garson 2000). The Cheer pheasant *Catreus wallichi* was considered vulnerable (Fuller and Garson 2000) and its threat was categorized as C_{2a} i.e. continuing to decline in numbers and severely affected by fragmentation (Collar *et al.* 1994). The Cheer pheasant occurs in the western Himalayas from Northern Pakistan through Kashmir into Himachal Pradesh, Uttranchal in India and east to Central Nepal (Gaston *et al.* 1992). This bird inhabits steep hillsides with grass and scrub, dissected with woody ravines between 1000 – 3500 meters (Ali and Ripley 1987, Lelliot 1987). These birds seem to have a strong affinity for the early successional habitats maintained by frequent human intervention (Garson *et al.* 1992).

Population monitoring is considered to be a useful tool for evaluating the population trends and is necessary for devising suitable management strategies for bird populations. No universal method for estimating bird densities is available and appropriate methods may vary from species to species and also time, budget, place study etc (Clobert & Lebreton 1991).

Absolute density refers to any total counts of a population per unit area at a specific time. In theory, high levels of accuracy and precision are possible with absolute counts. However, such levels of accuracy and precision are usually not possible in the field conditions. Therefore, few studies have compared absolute counts with density estimates (Bibby *et al.* 1992).

Indirect methods of density estimation (indices) rely on counting signs of a bird activity (e.g. droppings, footprints, calls and feeding signs) and are particularly suitable for secretive bird species particularly galliform. Such counts are usually designed to be easy to carry out whilst giving reasonably accurate and precise information on relative population levels (Bibby *et al.* 1992).

For any population indexing technique it is necessary that it should be relatively simple, economical and easy to carry out whilst having satisfactory level of precision and accuracy.

A true population census (i.e. an enumeration or count) is not generally possible for bird species in wild. However, there are several techniques, which provide some useful indices of the population density in galliformes. Several studies on galliformes density indices have been done by many workers (Gaston 1980, Garson, 1983, Bo *et al.* 1997, Khaling *et al.* 1998, Kalsi 1998, Khan *et al.* 2000, Nawaz *et al.* 2000, Kaul and Shakya 2001).

Cheer call regularly at dawn and dusk during the breeding season and counts of the calling males have been used to derive density estimates (Ali & Ripley 1987, Roberts 1991, Young *et al.* 1987, Kaul 1989, Kalsi 1998).

The following were the objectives of the study:

1. Map the distribution of the Cheer pheasant in Himachal Pradesh.
2. Map the distribution of the Cheer in the Majathal – Harsang wildlife Sanctuary.
3. Obtain the density indices as well as see the changes in the population over the period of time at Majathal – Harsang Wildlife Sanctuary, Himachal Pradesh, India.
4. Comment on the suitability of the call counts for estimating abundance.

3.2 Methodology:

A review of the available literature and personal communications were pooled together about the Cheer pheasant through out its range in India as well ass globally (Ali & Ripley 1987, Roberts 1991, Young *et al.* 1987, Kaul 1989, Kalsi 1998).

Following previous literature on Cheer pheasant (Garson 1983, Kalsi 1998), extensive surveys were conducted to establish the presence/absence and distribution of cheer in different parts of the Majathal-Harsang Wildlife Sanctuary. During extensive surveys, apart from identifying cheer sites, area for intensive ecological study was also delineated. At each cheer calling site following, data on the macro-habitat parameters were collected by ocular estimation – tree cover, shrub cover, grass cover and bare ground (Table 3.1).

Table 3.1 Landscape habitat characteristics at cheer sites in and around Majathal-Harsang Wildlife Sanctuary

S.No.	Name of Site	Aspect	Slope	Broad habitat	Forest %	Shrub %	Grass %
1	Surag dawari	NE	70	Open-pine	25	10	65
2	Banola Forest Reserve	SW	50	Open-pine	30	20	50
3	Malokda	SW	50	Grassland	10	20	70
4	Talau East	NE	50	Open-pine	40	10	50
5	Talau West	SW	70	Grassland	20	10	70
6	Opposite Forest Track House (Kangri Village)	NE	50	Scrub	5	65	30
7	Behind Harsang Temple	SW	80	Grassland	20	10	70
8	Cambi ka Dwar	NE	80	Grassland	20	0	80
9	Nali Ki Ghati	NW	80	Open-pine	35	15	50
10	Khurmbai	SW	45	Scrub	10	60	30
11	Behind Badu Bara Temple	NE	60	Open-pine	40	10	50
12	Matrech	NW	70	Open-pine	35	15	60

3.2.1 Dawn call counts:

Call counts were conducted (Kimbal 1949, Gaston 1980) at Cheer calling sites in the Majathal-Harsang Wildlife Sanctuary. These cheer calling sites were identified during extensive surveys through direct sightings and indirect evidences, and available literature. At all cheer sites, call count stations were marked. The stations were located at vantage points. The number of observation points for call counts was determined by the size of the site. In order to minimize the possibility of missing out any calling group, the observers were placed 600 meters apart (Gaston 1980). Each observer covered an area of approximately 300 m radius. All calling stations were permanently marked so that these could be monitored subsequently. At each calling station, the observer noted down the time of the first call and the last call, direction of the call, number of calls as well as number of calling groups. The calling groups were marked on an appropriately designed data sheet

At each selected site dawn calls counts were conducted for three consecutive mornings in order to reduce any discrepancies in recording the number of calling groups at each calling station as all the calling groups may not call every morning (Khaling *et al.* 1998). For dawn calling surveys, the calling stations were manned 30 minutes before sunrise until 60 minutes after sunrise. In order to reduce observer bias the observers were shifted in such a manner that the same observer did not monitor the same calling station on two consecutive days. All double counts were eliminated after the call counts were done.

3.3 Data Analysis:

The distribution map of the Cheer pheasant was made with the help of the Software program ArcView 3.1. For density indices, each calling position detected was treated as individual data point. Data on only dawn call counts was used because no significant difference was found in calling between dawn and dusk (P = Ns). The density estimates were calculated following Duke (1989). The number of calling station had a mean audible range of 300 meters. The area covered at each calling station was considered a semicircle as all the calling stations were hilltops and we monitored only one side at a time. The mean area covered was 0.28 km^2. One way Analysis of Variance (ANOVA) was conducted to see the variation between the calling groups, between different sites as well as between the years and between the previous workers. All analysis was performed using the software SPSS ver. 11 for Windows.

3.4 Results:

3.4.1 Cheer distribution at the Global level:

The Cheer pheasant is distributed through the southern foot hills of the Himalayas from Pakistan through India up to Pakistan. The species have a limited range in Pakistan occurring only in the north western frontier province. In India, it is distributed in the states of Jammu and Kashmir, Himachal Pradesh and Uttaranchal while in Nepal it occurs from western border to the Kali Gandaki River (Fig 3.1).

3.4.2 Cheer distribution Himachal Pradesh:

The state harbors numerous sites and perhaps holds the best population of the Cheer pheasant in the world. Within the state it was reported in one national park and 12 wildlife sanctuaries (McGowan & Garson 1995). Marshal (1884) reported the presence of cheer near Chamba district. Gaston *et al.* (1981b) heard two calling birds at Sara forest reserve, heard 1-3 birds near Budhal Nullah in Kugti Wildlife Sanctaury. They also sighted five birds near Hamta Nullah and also saw cheer at Lam Dubh Manasu in 1980 in Manali Wildlife Sanctuary. The one to two birds were heard at Khajjar between November 1978 and January 1979 in Khajjiar-Kalatop Wildlife Sanctuary and one pair was heard at the lower end of Garanhan Nullah in Kanawr Wildlife Sanctuary. The cheer was also reported from Great Himalayan National Park, Trithan Wildlife Sanctuary, Majathal Wildlife Sanctuary, Chail Wildlife Sanctuary and Sahrahan. Garson (1983) heard two birds near Rolla and two birds at Shugarde and a minimum of three pairs were seen near upper Sainj River. He recorded 19 pairs in Majathal-Harsang Wildlife Sanctuary and a minimum of 32 pairs in Chail Wildlife Sanctuary in March 1983. Sharma and Pandey (1989) and Sharma *et al.* (1990) reported the presence of Cheer pheasant at various sites in Himachal Pradesh, Raung, Kao, Kaksthal, Danranghati Wildlife Sanctuary, Kinnu Timura, Kotgarh, Kyari Bangla, Janaur, Bassal, Shogi , Bhasa, Seri, Moi Jubbal, Thund and Chail Wildlife Sanctuary. Singh *et al.* (1990) gave the distribution of the Cheer pheasant in different protected areas in the state like Great Himalayan National Park,

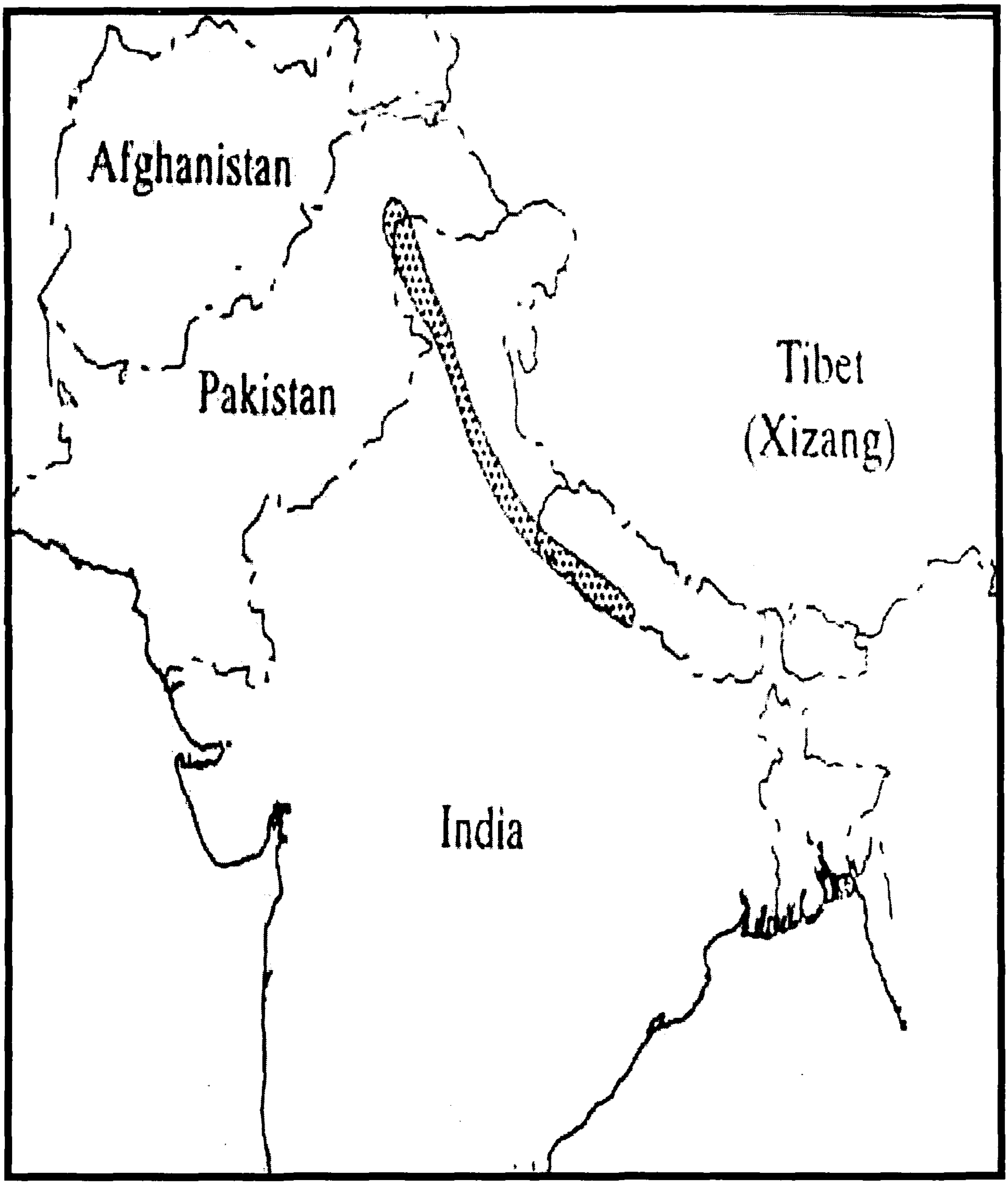


Figure 3.1 Global distribution of cheer pheasant

Gamgul Wildlife Sanctuary, Tundah Wildlife Sanctuary, Kugti wildlife Sanctuary, Manali Wildlife Sanctuary, Kais Wildlife sanctuary, Kanawar Wildlife Sanctuary, Nargu Wildlife Sanctuary, Trithan Wildlife Sanctuary, Shikari Devi Wildlife Sanctuary, Bandli Wildlife Sanctuary and Talra Wildlife Sanctuary. Jandrotia *et al.* (1995) heard eight cheer calling in the same area. In Chamba, Kalsi (1998) reported four calling positions per square kilometer from Sara Forest Reserve, five calling positions per square kilometer in Bhaatal and four calling positions per square kilometer in Tundah wildlife Sanctuary. Gaston *et al.* (1981b) heard one to three birds calling near the Kuti Nullah in May 1980. Jandrotia *et al.* (1995) saw eight cheer pheasants in Sara Forest Area, sighted seven cheer pheasant and heard 10 – 14 birds in Thathana Reserve Forest. Kalsi (1998) did survey the four districts of the Himachal Pradesh and reported the Cheer density indices at these sites. The density index at Majathal-Harsang Wildlife Sanctuary was 17 calling positions per square kilometer, five calling positions per square kilometer at Chail wildlife sanctuary, three calling positions per square kilometer at Kaksthal. Thathana Reserve Forest and Bhaatal had a Cheer density index of five calling positions per square kilometer while Sara Reserve Forest and Tundah Wildlife Sanctuary had having a density index of four calling positions per square kilometer. The Cheer pheasant has also been reported from the Churdar Wildlife Sanctuary (M.L. Narang pers. comm. 1995) (Fig 3.2).

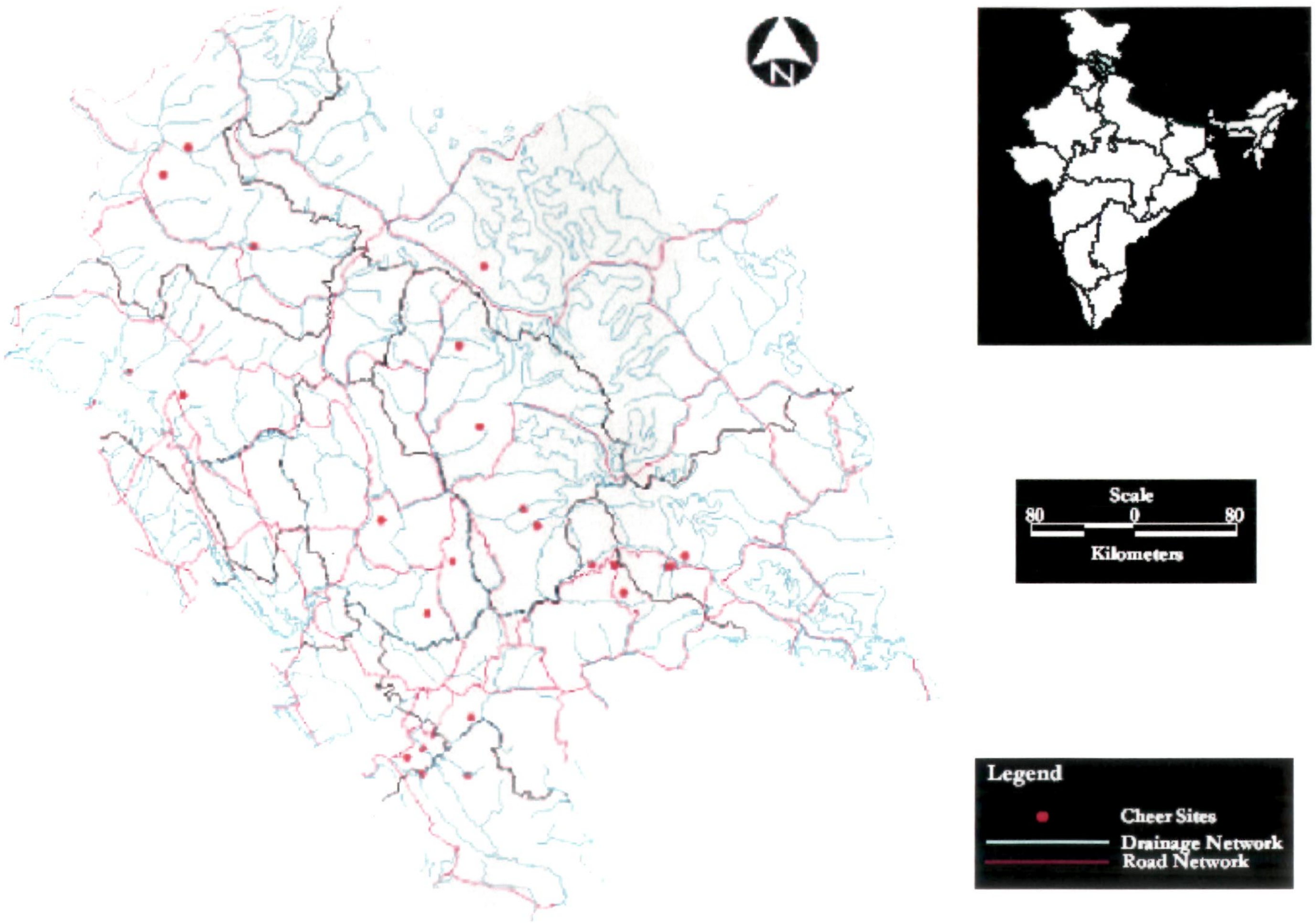


Figure 3.2 Distribution of Cheer pheasant in Himachal Pradesh.

3.5 Density Index in and around Majathal-Harsang Wildlife Sanctuary.

3.5.1 Across years.

The mean density index in Majathal-Harsang Wildlife Sanctuary over the years (1999-2001) was 5. 612 ± 0.453 ($n = 147$) calling positions per sq. km. Table (3.2). The mean density index varied significantly across the years ($F= 14.547$, $df = 2$, $p < 0.01$, One-way ANOVA). The density index did not vary between the years 1999 and 2000 but it varied significantly between the year 1999 and 2001 ($p < 0.01$, Multiple Comparisons Bonferroni MCB). The mean density index also varied significantly between years 2000 and 2001 ($p < 0.01$, MCB).

Table 3.2 Density index (calling positions per sq. km.) of cheer in Majathal-Harsang Wildlife Sanctuary over the years.

Year	Mean	±Standard Error	Minimum	Maximum
1999	3.289	0.730	.000	10.714
2000	4.448	0.560	.000	14.285
2001	8.585	0.850	.000	17.857
Total	5.612	0.453	.000	17.857

3.5.2 Across months

The mean density index of cheer over the months (April, May and June) was found to be 5.612 ± 0.453 ($n = 147$) calling positions per sq. km. (Table 3.3), it varied significantly across the months ($F = 17.082$, $df = 2$, $p < 0.01$, One-way ANOVA). The density index varied significantly between the months of April and May ($p < .01$, MCB) while it did not vary significantly between April and June. Density index also varied significantly between the months of May and June ($p < 0.01$, MCB).

Table 3.3 Density index (calling positions per sq. km.) of cheer in Majathal Wildlife Sanctuary over the months.

Months	Mean	±Standard Error	Minimum	Maximum
April	2.551	0.808	0.000	10.714
May	8.241	0.590	0.000	17.857
June	4.034	0.749	0.000	17.857
Total	5.612	0.453	0.000	17.857

3.5.3 Over sites across years.

a) Suragdawari :

The mean density index over the years was 3.77 ± 0.840 ($n = 18$) calling positions per sq. km (Table 3.4), and it varied across the years ($F = 49.688$, $df = 2$, $p < 0.01$, One-Way ANOVA). The mean density index varied significantly between the years 1999 and 2000 ($p < 0.01$, MCB) as well as between the years 1999 and 2001 ($p < 0.01$, MCB). The mean density indices also vary significantly between the years 2000 and 2001 ($p < 0.01$, MCB).

b) Banola Forest reserve:

The mean density index was found to be 9.777 ± 0.904 ($n = 18$) (Table 3.4), which did not varied significantly over the years ($F = 6.908$, $df = 2$, $p < 0.01$, One-way ANOVA). The mean density index did not vary significantly between year 1999 and 2000 as well as between the years 1999 and 2001. The mean density did vary significantly between the years 2000 and 2001 ($p < 0.01$, MCB).

c) Malokda:

The mean density index across years was 5.066 ± 0.867 (n= 43) (Table 3.4), which did not vary significantly ($F= 3.049$, $df = 2$, $p= 0.06$, One-way ANOVA). The mean density index did not vary significantly between years 1999 and 2000 as well as between 1999 and 2001, while it did not vary significantly between years 2000 and 2001.

d) Talao East:

The mean density index across years was 7.33 ± 1.432 (n = 19) (Table 3.4), which varied significantly across the years ($F = 6.187$, $df = 2$, $p < 0.01$, One-way ANOVA). The mean density index did not vary significantly between the years 1999 - 2000 while it varied significantly between year 1999 and 2001 ($p < 0.01$, MCB).

e) Talao West:

The mean density index across the years was 6.77 ± 1.248 (n = 19) Table 3.4, which varied significantly across the years ($F= 13.361$, $df = 2$, $p < 0.01$, One-way ANOVA). The mean density index did not vary significantly between year 1999 and 2000 while it varied significantly between the years 1999 and 2001 ($p < 0.001$, MCB) and 2000 - 2001 ($p < 0.01$, MCB).

3.5.3. Opposite to forest track house (Kangri village):

The mean density index across years was 3.21 ± 0.912 (n = 30) (Table 3.4), which varied significantly across the years ($F = 4.820$, $df = 2$, $p < 0.01$, One-way ANOVA). The mean density did not vary significantly between the years 1999 - 2000 and 2000 – 2001 while it varied significantly between the years 1999 - 2001 ($p < 0.01$, MCB).

Table 3.4 Density indices (calling positions per sq. km.) of cheer pheasant in Majathal Harsang Wildlife Sanctuary at various sites.

	Sites	1999	2000	2001
a	Suragdawari	0.00 (± 0.00) 0 – 0	4.37 (± 0.52) 4 – 7	9.52 (± 1.19) 7 - 11
b	Banola Forest reserve	9.523 (± 0.758) 7.142 – 10.714	7.589 (± 0.809) 3.571 – 10.714	14.285 (± 2.525) 7.14 – 17.857
c	Malokda	6.168 (± 1.282) 0.000 – 10.714	1.785 (± 1.281) 0.000 – 14.285	6.428 (± 1.433) 0.000 – 17.857
d	Talao East	0.0 (± 0.00) 0 – 0	6.35 (± 4.980) 0 - 11	11.73 (± 5.727) 0 - 18
e	Talao West	0.0 (± 0.00) 0 – 0	5.16 (± 1.471) 0 - 11	11.73 (± 1.020) 7- 14
f	Opposite to forest track house (Kangri Village)	0.0 (± 0.00) 0 – 0	2.86 (± 1.282) 0 - 11	6.17 (± 1.871) 0 - 14

Note: Mean (±Standard Error)

Minimum - Maximum

3.5.4 Density index at sites across months

a) Suragdawari:

The mean density across months was 3.77 ± 0.840 (n= 18) (Table 3.5), which did not vary significantly across months ($F= 1.398$, $df = 1$, $p = 0.254$, One-way ANOVA).

b) Banola Forest reserve:

The mean density across months across years was 9.722 ± 0.904 (n= 18) (Table 3.5), which did not vary significantly across the months ($F= 1.694$, $df = 1$, $p = 0.211$, One-way ANOVA).

c) Malokda:

The mean density across months was 5.066 ± 0.867 (n = 43) (Table 3.5), which varied significantly across the months ($F = 10.698$, $df = 2$, $p <0.01$, One-way ANOVA). The mean density index varied significantly between the months of April and May ($p < 0.01$, MCB) and May and June ($p < 0.01$, MCB) while there was no significant difference between the months of April and June.

d) Talao East:

The mean density index across the months was 7.330 ± 1.431 (n = 19) Table 3.5, which did not vary significantly across the months ($F = 1.044$, $df = 2$, $p = 0.375$, One-way ANOVA). The mean density index did not vary significantly between months.

e) Talao West:

The mean density index across months at this site was 6.77 ± 1.248 (n= 19) Table 3.5, which did not vary across the months ($F = 1.851$, $df = 2$, $p = 0.189$, One-way ANOVA). The mean density index did not vary significantly between months.

Table 3.5 Density indices of cheer pheasant (calling positions per sq. km.) in different months at different sites in Majathal-Harsang Wildlife Sanctuary.

	Sites	April	May	June
a	Surag dawari		4.66 (± 1.088) 0 - 11	2.38 (± 1.190) 0 - 11
b	Banola Forest reserve		10.238 (± 1.037) 3.571 – 17.857	7.142 (± 0.00) 7.142 – 7.142
c	Malokda	1.275 (± 0.886) 0 – 10.714	9.438 (± 1.329) 0 – 17.857	4.523 (± 1.414) 0 – 14.285
d	Talao East	9.523 (± 1.190) 7.142 – 10.714	9.183 (± 1.171) 3.571 – 17.857	5.158 (± 2.602) 0 – 17.85
e	Talao West	8.333 (± 2.380) 3.571 – 10.714	9.183 (± 1.062) 7.142 – 14.285	4.365 (± 2.209) 0 – 14.285
f	Opposite to forest track house (Kangri Village)	0.00 (± 0.00) 0 - 0	6.785 (± 1.801) 0 – 14.28	2.380 (± 0.911) 0 – 14.285

Note: Mean (±Standard Error)

Minimum - Maximum

f) Opposite to forest track house (Kangri village):

The mean density index across the months was 3.214 ± 0.911 (n= 30) Table 3.5, which varied significantly across the months ($F = 5.85$, $df = 2$, $p < 0.01$, One-way ANOVA). The mean density index did vary significantly between the months of April and May ($p < 0.0$, MCB) while there was no significant difference in the density index between the months of April and June and of May and June.

3.5.5 New Sites discovered during surveys:

During the study six new sites of Cheer pheasant were identified Table 3.6. There was no significant difference between the density indices at the new sites ($F = 1.39$, $df = 5$, $p = 0.246$, One-way ANOVA). The first three sites were in the Harsang area and the site behind Badu Mandir was in the Majathal area. These sites are within the protected area boundaries. The site Khurmbai was just at outside the protected area boundary of the sanctuary while other new site at Matrech lies under the jurisdiction of Bilaspur district. This is the only site of Cheer pheasant recorded so far from this district.

Table 3.6 Density index (calling positions per sq. km.) of cheer pheasant at new sites found in and around Majathal-Harsang Wildlife Sanctuary.

Sites	Mean	±Standard Error	Minimum	Maximum
Behind Harsang Temple	2.777	0.396	2.381	3.574
Cambi ka Dwar	2.777	0.396	2.381	3.574
Nali Ki Ghati	3.571	1.030	1.785	5.357
Behind Bado Bada Temple	4.719	1.030	0.000	10.714
Khurmbai	8.333	1.190	7.142	10.714
Matriage	7.380	1.068	0.000	17.857
Total	6.069	0.684	0.000	17.857

3.6 Discussion:

In the earliest records available, the species has been considered generally scarce and local (Hume and Marshall 1879-1881). It always had a very patchy distribution and specialized habitat requirements (McGowan and Garson 1995). The total numbers of birds present in the wild were estimated to be less than 5000 birds. Many populations consisted of few individuals (Kalsi 1998) in isolated pockets of suitable habitat (McGowan & Garson 1995). Population densities have been estimated at 5 - 10 breeding females per square kilometer at several sites (Lelliott 1981a, b, Garson 1983, Garson *et al.* 1992) suggesting that in ideal conditions many individuals can survive in small areas.

Himachal Pradesh has always been the stronghold of Cheer pheasant. During the twentieth century a decline in the population occurred (McGowan & Garson 1995). By the 1980's it disappeared from many localities where it was reported earlier (Garson *et al.* 1981b) and reports suggested that the numbers of the species continued to decline in the 1990's (Kalsi 1998). By the turn of the last century, the majority of the surviving populations were found in the hills of the Himachal Pradesh (Gaston and Singh 1980, Garson *et al.* 1981b, 1983, Sharma and Pandey 1989, Kalsi 1998) where surveys revealed that most of the populations and were in the isolated pockets, were small and tolerably well distributed (Garson *et al.* 1981 b) and locally quite common (Kaul 1992 b). Most of the sites held fewer then 10 pairs (Garson *et al.* 1981 b). Two locations in the state harbouring good populations of the birds were Chail and Majathal-Harsang Wildlife Sanctuary. Garson and Singh (1980) and Garson *et al.* (1981b) reported a population of 40 pairs with an average density of six pairs per square kilometer. This population apparently declined by around 50% between 1979 and 1983 (Garson 1983) when fire swept through a large portion of Chail WLS. The highest population densities for this species were recorded in Majathal-Harsang Wildlife Sanctuary. Garson (1983) reported 24 pairs per square kilometer in 1983 while Kalsi (1998) estimated 17 calling positions per square kilometer in suitable habitat. Gaston *et al.* (1981 b) felt that 50 pairs were surviving in Bundal Nullah, while in upper Beas Valley, the species was present at every site visited by them and the population may have been in hundreds. They concluded that the species was safe and the population in the state of Himachal Pradesh was more than a thousand birds.

Majathal-Harsang Wildlife Sanctuary has historically been a suitable habitat for the Cheer pheasant. This sanctuary harbours extensive grasslands with patches of Chir Pine; the suitable habitat of cheer. There are 17 villages in the sanctuary, and the local human population is directly dependant upon the sanctuary for grazing their livestock. The grasslands have traditionally and regularly been maintained by annual cycles of grazing, cutting and burning. Earlier surveys in different areas of Himachal Pradesh have also reported higher Cheer pheasant numbers and densities in Majathal-Harsang Wildlife Sanctuary as compared to other areas in the state.

Cheer pheasant was distributed in many habitats such as grasslands, scrub and open pine habitats. Pheasants are difficult to observe in their habitats due to their shy nature and the use of undergrowth for cover. Call counts revealed that there was an increase in the calling groups over the years. Significant differences were found between years 1999 and 2001. Garson (1983) gave an estimate of 24 pairs / km^2 while Kalsi (1998) gave the density index of 17 calling groups / km^2. Density estimates in the present study were low as compared to those given by Garson (1983) and Kalsi (1998). These density indices did not vary significantly over the years. The differences were perhaps due to the estimation of area by previous workers. Since the surveys by earlier workers were of short duration, and they seemed to have under-estimated the area of these sites thus boosting their density estimates much higher than the present study.

Calling can also be affected by several factors such as weather, time of the day and year. Therefore, using the highest number of birds heard during a survey may be prone to errors. The most reliable population index may be derived from the mean number of callers heard from different points. These estimates also take care of variations in the calling frequency of groups between days as all the calling groups may not call every morning. Garson (1983) during his surveys in 1983 did counts at each site on a single day and reported a minimum of 19 cheer. Kalsi (1998) also did not provide any details of the variations that occurred in calling rates of Cheer pheasant during the surveys. As the present study was for a longer duration it was possible to provide mean as well as the standard error, which provided a more robust index.

The population in the sites, which were monitored for three years, seemed not to change significantly. Although juveniles were seen in the winters, there was no apparent change in the population it seemed that there might have been some mortality during winters or the birds might have been predated or dispersed to different areas.

Spring call counts are easy to carry out especially for those birds which are shy and cryptic in nature (Nawaz 1999). The spring call counts have been conducted for a number of Himalayan pheasants. Lelliot & Yonzon (1980), Khaling *et al.* (1998) for Satyr tragopan, Khan & Shah (1982) for Koklass pheasant, for Western tragopan (Duke 1989), Akhtar *et al.* (1994), Nawaz (2000) and Khan *et al.* (2000) and as well as for Cheer pheasant by Gaston & Singh (1980), Young *et al.* (1987) and Kalsi (1998). In most of the studies on pheasant densities in India, Pakistan and China, the method of call counts was the only suitable and preferred method due to the nature of the habitat and terrain (Woodburn 1993). Density indices obtained from the call counts may be compared between different sites and within the same sites between the years.

Cheer pheasant gives regular dawn and dusk calls during the breeding season, which starts in April and lasts till June. The maximum numbers of the calling days were 60 in both the years. This makes the calling period the most suitable time for conducting abundance studies on the Cheer pheasant.

The studies done in the past using call counts assumed that during the breeding season, each calling male may be accompanied by at least one female. The density indices of the cheer from these surveys were reported as pairs of Cheer pheasant / km^2. This approach either led to underestimation of the cheer density where one calling male at the start of the breeding season may be attracting more than one female present in an area. It can also lead to an overestimation of cheer density where an unmated male in an area also calls and is counted as a pair. Other surveys of cheer reported only the numbers of cheer heard without taking into account the size of area surveyed. This method was modified by Kalsi (1998) by taking into account number of the calling positions rather than calling male thus giving the indices in calling positions/km^2, with an advantage that the chances of the over or under estimation of calling groups were minimized.

There were some difficulties while using call counts method to estimate the density index of Cheer pheasant in Majathal-Harsang Wildlife Sanctuary. These difficulties have also been experienced by workers studying other pheasant species (Duke 1989, Picozii 1985, 1987, and Khaling *et al.* 1998).

1. Accurate estimation of the distances between the observer and calling group was not possible. To overcome this, calling birds were divided into different distance classes.
2. The terrain and topography made audibility, distance assessment and judgment of the direction of calls difficult, which might have led to over or under counts. This was true when the birds were far away or if the bird was at the bottom of the valley and calls were bounced back.

Despite all these short comings, the method of call counts was the most appropriate technique for obtaining density indices and establishing the presence and absence of vocal pheasant species in an area. The dawn and dusk chorus is very pronounced, and doing call counts requires little expertise, expenses and time. It is a non-invasive technique, which causes little or no disturbance to the birds during the breeding season. It is a suitable method for short surveys because of little effort and resources required. For long-term monitoring, this method can be used in previously surveyed areas without changing the call count points, which will give population dynamics of a species. To ensure that all the calling groups are heard at a calling station, it is preferable to do counts for three consecutive days as each individual may not call every morning. The terrain itself determines the distance between the observers. The distance between the observers was kept at 600 meters so that the no calling group was missed out between two adjacent observation points.

The call count method provides density indices, which are not absolute measures of the density of a population. Use of such indices relies on the assumption that the indices represent a constant but unknown proportion of the population (Clobert & Lebreton 1991). However, data should be treated with caution as extrapolation to produce absolute counts and measures of absolute density may produce erroneous results for reasons discussed above. Above all calibration should ensure that the relative measures are comparable (Clobert & Lebreton 1991).

Chapter 4

Calling Behaviour

4.1 Introduction

Animals use a variety of means to communicate information about status, alarm, food, territories, etc. to other individuals of the species. The medium of communication may be visual, acoustic, tactile, and even chemical and electrical signals. Bird behaviour is dominated by visual and acoustical communications. Birds have highly developed sound production organs among animal kingdom (Welty 1982). These vocal abilities are due to a unique organ called Syrinx, which produces loud, complex sounds and can even produce two sounds simultaneously (Gill 1989). Communication occurs whenever the action of one animal influences the other. This influence usually involves the transfer of information between the individuals in the form of either visual displays or sounds, predominantly the sounds (Welty 1982).

Bird vocalization is of two kinds: calls and songs. Thorpe (1956, 1964) defined calls as "brief sounds with relatively simple acoustic structure". They are mono- or disyllabic and involve more than four or five notes. In longer bursts of calls, there is no clear organization or pattern and may continue as long as impinging external circumstances. They are mainly concerned with coordinating behavior of other members of the species in a non-sexual maintenance behavior and reaction towards predators.

Calls appear to be the usual form of communication in addition to displays shown by birds. There are wide variations in calls (e.g. distress calls, flight calls, warning calls, feeding calls, nest calls, begging calls etc.) used for communication for different purposes (Thorpe 1961). The advertisement call is loud and can be heard over a long distance and is usually referred to as territorial or breeding call and also as crowing and female attraction calls

(Gaston 1980, Lelliot and Yonzon 1980, Johnsgard 1986, Islam and Crawford 1996, Young *et al.* 1997, Khaling 1998). Calls are apparently genetically determined.

Songs are defined as a series of notes of different types "uttered in succession and related to form a recognizable pattern in time." A song is more complex in rhythm and modulation than a series of call notes (Thorpe 1956, 1964). Songs are primarily governed by sex hormones in males and are generally concerned with the reproductive cycle. There is no real dichotomy between songs and calls in either their acoustic structure or function (Greenewalt 1968).

Although scientific studies on avian vocalization commenced 400 years ago on ducks and chickens (Greenewalt 1968), little attention has been paid to bird calls (Guttinger and Nikolai 1973, Thielckee 1976, Baker and Bailey 1987, Baptisa 1990). Significant work, however, has been undertaken on bird songs (Morse 1970, Emlen 1974, Lein 1971, Catchpole 1973, Krodosoma 1976, Mace 1986, Moller 1988, Birkhead and Moller 1992, Welling *et al.* 1995).

All the pheasant species have distinct vocalization patterns and most of them have the habit of crowing regularly and are more vocal at the dawn and dusk (Johnsgard 1986). Although several studies (Collias and Collias 1967, Young *et al.* 1987, McGowan 1992, Islam and Crawford 1996, Khaling 1998) documented vocalization patterns of different species of pheasants, the phenomenon of vocalization in pheasants is not fully known.

The Cheer pheasant has a very complex but distinctive set of calls and can be heard upto a mile from its occurrence point (Jerdon 1864). Most of the studies by various workers (Beebe 1922, Ali and Ripley 1987, Delacour 1977; Hume and Marshall 1879; Blanford 1898) reported cheer call differently: 'Chir-a-pir, Chir, Chirchirwa and Cherwa'. Whistler (1926) gave more detailed description "a series of noisy squeaks and chucklets which ring out.......... with clamour that one is accustomed to associate with a guinea fowl". Some of the notes resemble those of the species itself, whereas others are exaggerated versions of the squeak of Silver Pheasant and some relate it with Chukar partridge. Although Cheer pheasant mainly calls like "Chook-Chook-Cherwea, Cherweewea (Lelliott 1981), five different calls of the species have been described by Young *et al.* (1997) and Kaul (1989).

The calling behavior data collected for Cheer pheasant was to answer following questions:

1) Do all the calling birds call on each dawn as well as at dusk?
2) Is there any variation in the number of groups over a time interval?
3) What are the probable functions of the calls?
4) What are the implications of call counts in population monitoring of Cheer pheasant?

4.2 Methodology

Several different field techniques can be used to derive density index estimates of galliformes such as line dives with dogs, call counts, call counts using live lures or recorded calls to elicit calling from wild birds and visual counts (Gaston 1980, Young *et al* 1987, , Bo and Dowell 1997, Khaling *et al.* 1997, Khan *et al.* 2000, Nawaz *et al.* 2000). No universal method is applicable for estimating bird densities and appropriate methods may vary according to species, time and place of study (Clobert and Lebreton 1991).

Call counts were conducted following Call Count Method (Kimbal 1949; Gaston 1980; Young *et al.* 1987; Duke 1989; Kaul 1989; Khaling 1998) in order to study calling behavior of Cheer pheasant.

The data were collected from 5 April 2000 to 29 June 2000 (65 mornings and evenings), 4 April 2001 to 30 June 2001 (69 mornings) and 3 April 2001 to 30 June (77 evenings). Calls were counted using synchronized digital watches prior to counts. The time of first and the last call was recorded at each call count session. Besides, the direction of call, frequency of calls given by each calling male, duration of call and number of calls given in a bout were also recorded.

4.3 Data analyses

The entire dawn and dusk calling duration comprised of several bouts and calls. Each "bout" consisted of several calls given without interruption. The calling frequency for a particular day was expressed as percentage and was computed as follows:

$$\textbf{Calling frequency} = \frac{\textbf{Number of calling males at a particular station}}{\textbf{Maximum calling males heard at that particular station}}$$

The data for each station for each day was pooled together monthwise. Mean values of number of calling males for each month in the breeding season were calculated and their confidence limits were set following standard statistical methods of Zar (1984). The mean values obtained were subjected to One-way Analysis of Variance (ANOVA) in order to find out differences in calling frequencies over the months as well as in breeding season. The number of calling birds as well as their calling behaviour was analyzed monthwise during the breeding season. Multiple comparisons were made between the calling frequency, calls and duration of calls across month. The data was also subjected to Mann – Whitney U – tests in order to compare the differences between the breeding seasons of the year 2000 and 2001 as well between dawn and dusk periods. All the analyses were performed by using SPSS 11.

4.4 Results:

Cheer pheasant calls during breeding season from April to June. The main call of the Cheer pheasant during breeding was "Chut Cheeweewa..........." . The birds also called at times when approached by a predator, were flushed, or even when any member of the flock was left out of the way.

4.4.1 Calling Frequency:

Individual birds did not call at every dawn as well as at dusk. At dawn the calling frequency varied from 44% to 75% in year 2000 (Figure 4.1) while it varied from 22% to 77% in year 2001 (Figure 4.2). The mean calling frequency for the two years across the months was 57 %. The calling was at its peak in the month of May in both the years.

The calling frequency varied significantly between April, May and June during the year 2000 ($df = 2$, $F = 10.16$, $p < 0.05$, One way ANOVA) and for the year 2001 ($df = 2$, $F = 30.81$, $p < 0.05$, One way ANOVA). Significant differences were also found in calling at dawn in the months of April and May ($p < 0.05$). Dawn calling in the month of May differed significantly from that in April and June ($p < 0.05$) in year 2000 while in year 2001, significant differences in calling were found between April, May and June ($p < 0.05$).

At dusk, calling frequency varied from 32% to 90% in the year 2000 (Figure 4.3) while in the year 2001, the calling frequency varied from 22% to 75% (Figure 4.4). The mean calling frequency for the year 2000 was 58% while in year 2001 it was 50%. This indicated that the every calling group did not call at dusk. The birds were most vocal in the month of May in both the years. The calling frequency varied significantly between April, May and June during both the years (Year 2000 - $df = 2$, $F = 47.78$, $p < 0.05$, One-way ANOVA, and Year 2001 - $df = 2$, $F = 23.48$, $P < 0.05$, One-way ANOVA).

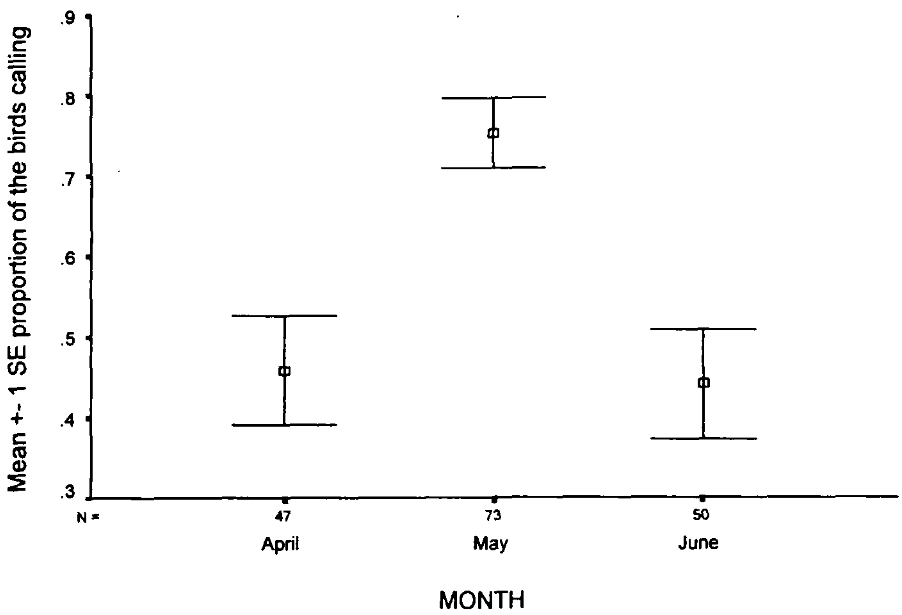


Figure 4.1 Calling frequency of the calling birds in different months at dawn in year 2000

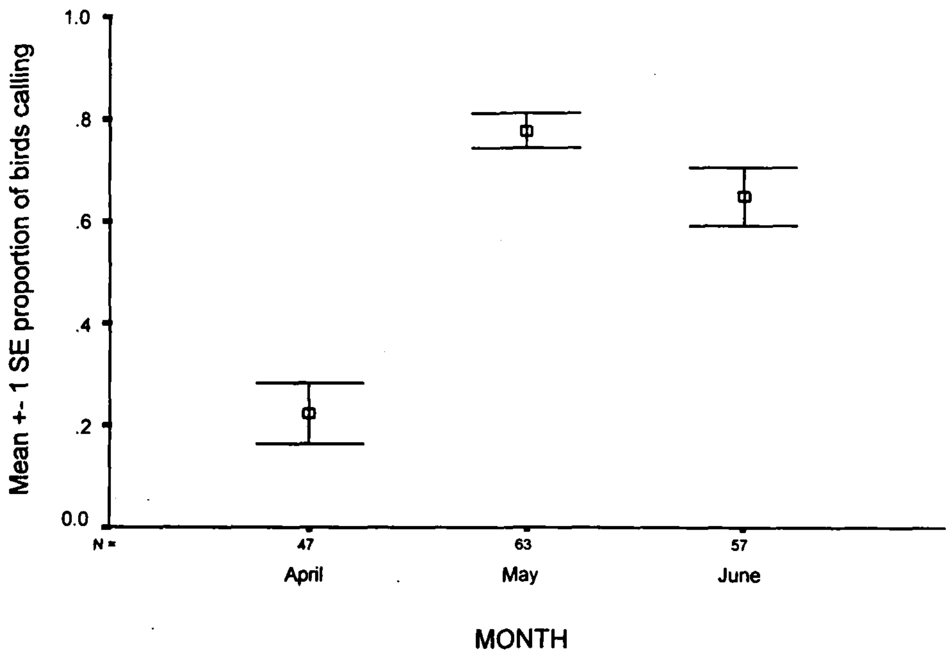


Figure 4. 2 Calling frequency of the calling birds in different months at the dawn in the year 2001

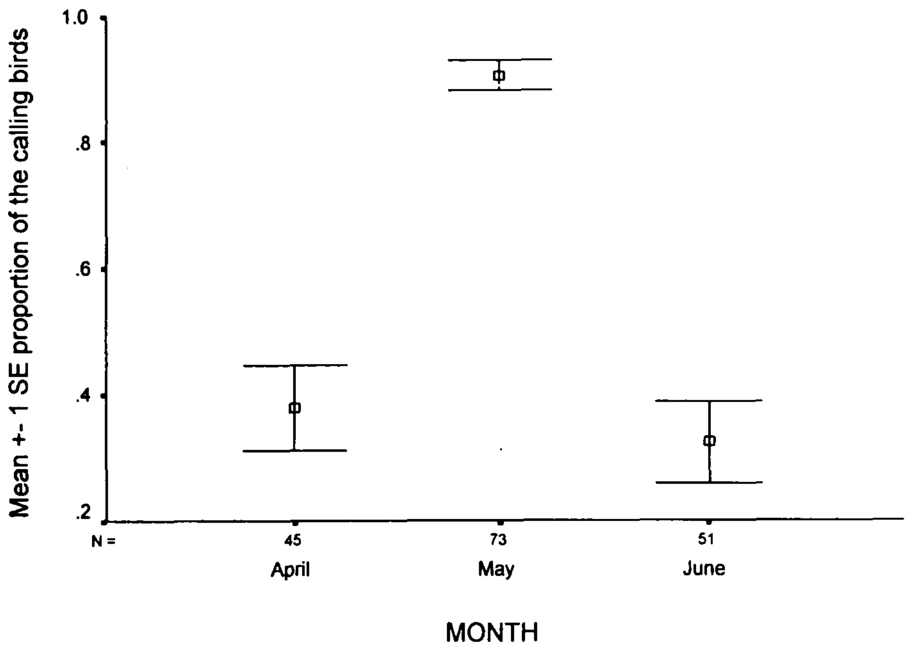


Figure 4.3 Calling frequency of the calling birds in different months at dusk in year 2000

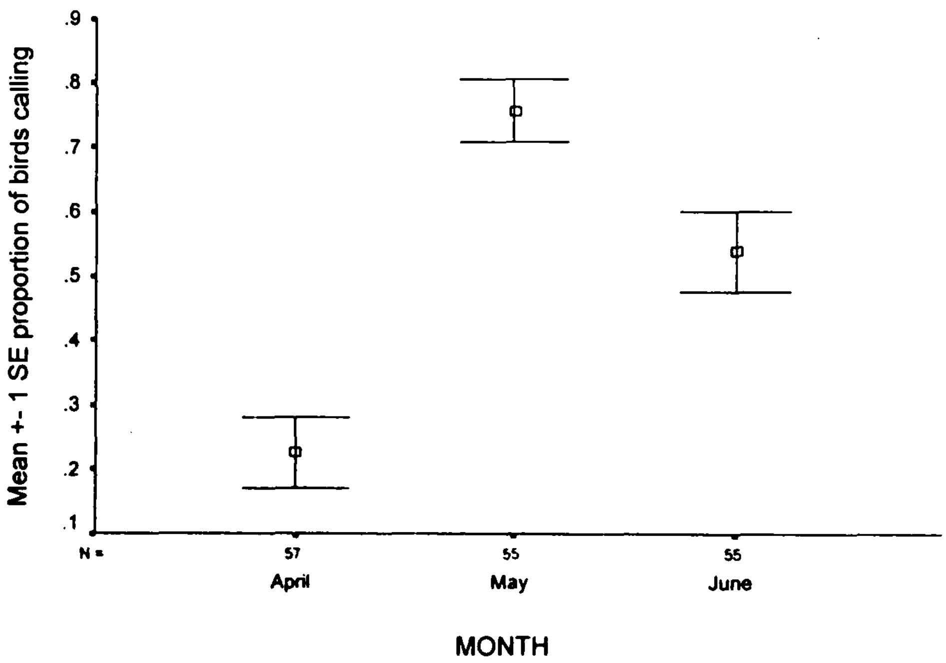


Figure 4.4 Calling frequency of the calling birds in different months at dusk in year 2001

4.4.2 Duration of Calling:

The mean duration of the calling was 5.08 minutes (± S.E. = 0.32 minutes, n = 203) in the year 2000 (Figure 4.5). The mean length of calling duration in April was 2.12 minutes (± S.E. = 0.24, n = 54), in May it was 8.42 minutes (± S.E. = 1.01 minutes, n = 94) and in the month of June it was 2.15 minutes (± S.E. = 0.32 minutes, n = 0.55). The duration of dawn calling varied significantly across the months (df = 2, F = 21.83, $p<0.05$, One-way ANOVA). The duration of dawn calling differed significantly between April and May ($p <0.05$) and May and ($p <0.05$). Mean duration of the calling for the year 2001 was 6.15 minutes (± S.E. = 0.22 minutes, n = 261). The duration of calling in the April was 2.37 minutes (± S.E. = 0.41 minutes, n = 61) while in the month of May it was 7.56 minutes (± S.E. = 0.32 minutes, n = 116) and in June it was 6.35 minutes (± S.E. = 0.36 minutes, n = 116) (Figure 4.6). The duration of calling varied significantly across the months (df = 2, F = 19.28, $p <0.05$, One-way ANOVA) (Figure 4.7). The duration of the calling in year 2001 in the month of April differed significantly from May and June ($p <0.05$). The duration of calling was longest in May in both the years. There was a significant increase in the length of duration of calling from April to May which declined in June 2000 while it sustained in June 2001.

The duration of calling at dusk in the year 2000 was 4.16 minutes (± S.E. = 0.20 minutes, n = 194). The mean duration of calling in the April was 3.12 minutes (± S.E. = 0.35 minutes, n = 51), in May it was 6.47 minutes (± S.E. = 0.32 minutes, n = 89) and in June the mean duration of the calling was 1.07 minutes (± S.E. = 0.20 minutes, n = 54) (Figure 4.8).

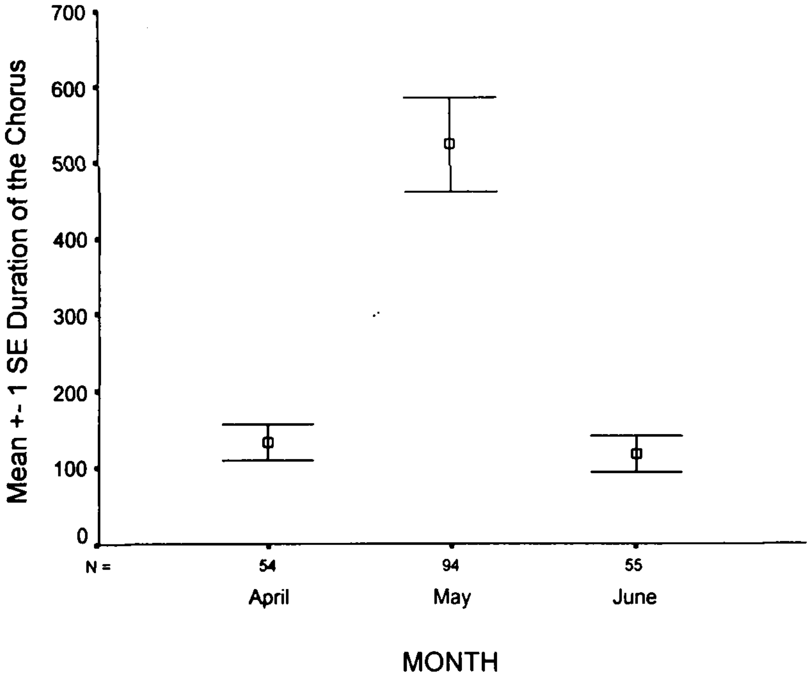


Figure 4.5 Duration of the chorus across the months at dawn in year 2000

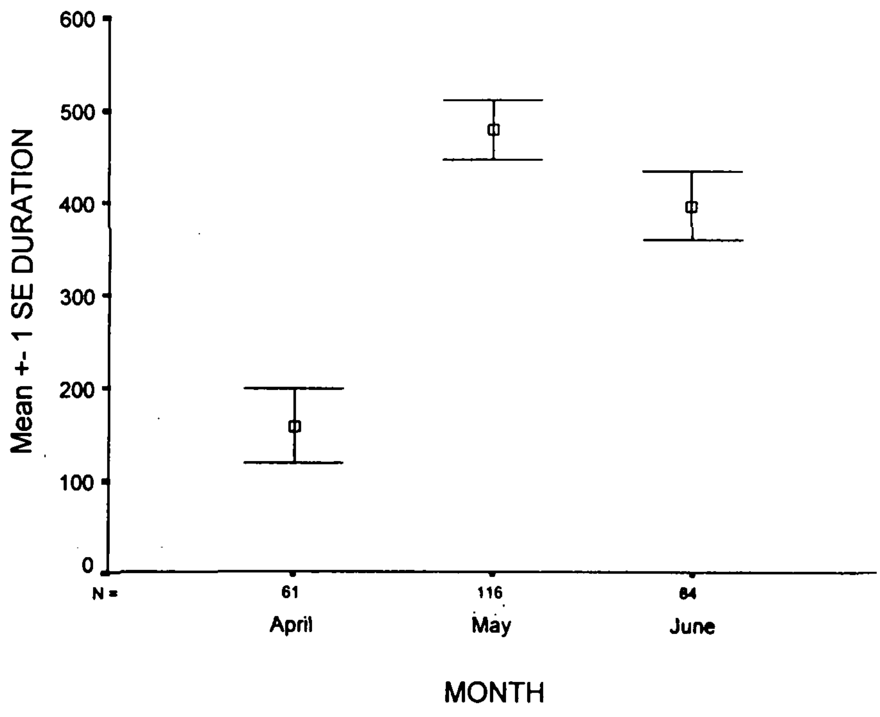


Figure 4.6 Duration of the chorus across the months at dawn in year 2001

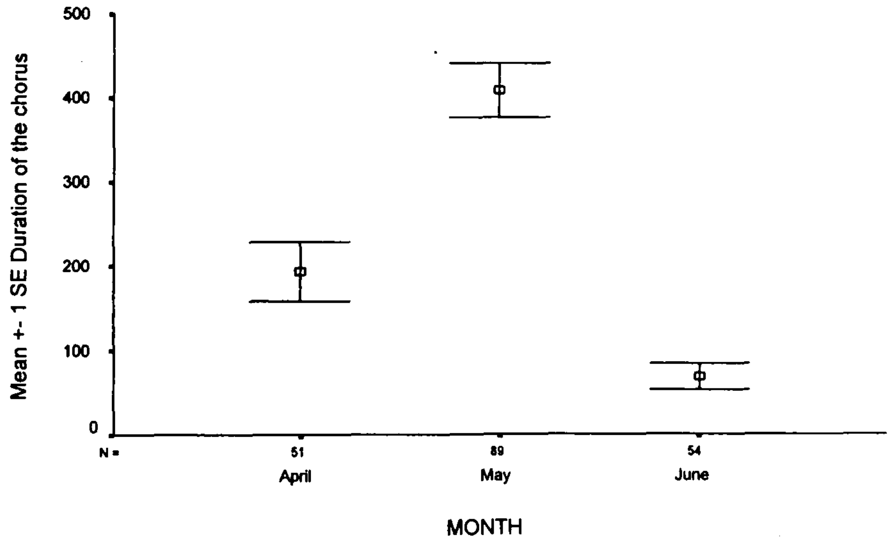


Figure 4.7 Duration of the Chorus across the months at dusk in year 2000

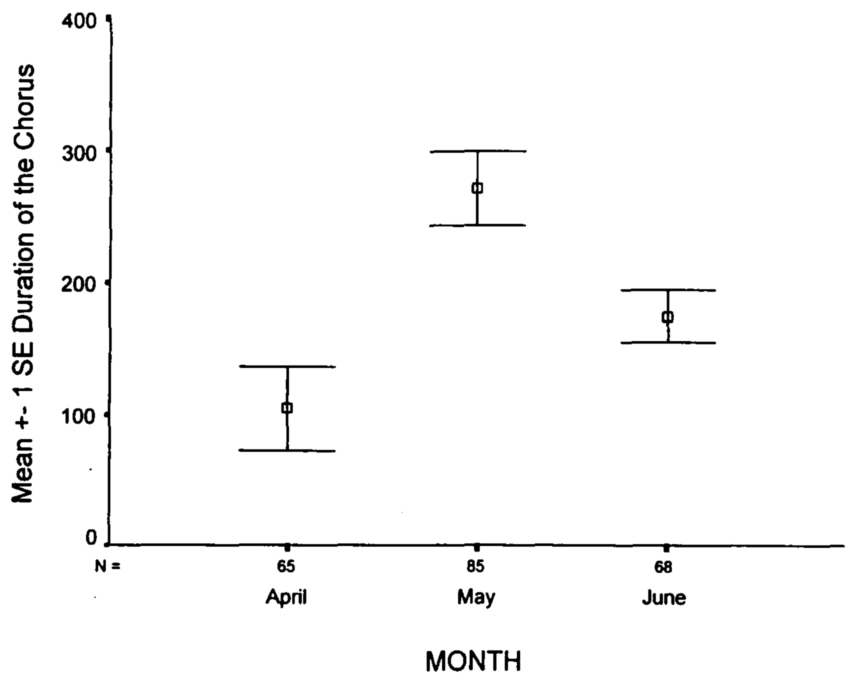


Figure 4.8 Mean duration of the chorus across the months at dawn in year 2001.

The mean duration of the calling varied significantly across the months (df = 2, F = 32.84, $p < 0.05$, One-way ANOVA). The duration of the dusk calling in the year 2001 was 3.10 minutes (± S.E. = 0.16 minutes, n = 218). The mean duration of the calling duration in the month of April was 1.44 minutes (± S.E. = 0.32 minutes, n = 65) while in the month of May it was 4.30 minute (± S.E. = 0.27 minutes, n = 85) and in the month June it was 2.53 minutes (± S.E. = 0.16 minutes, n = 68) (Figure 4.8). The mean duration of the calling varied significantly across the months (df = 2, F = 9.62, $p < 0.05$, One-way ANOVA). The longest calling durations were in the month of May in both the years. There was an increase in the duration of the calling from April to May in both the breeding seasons. The calling duration sustained in June 2001 while there was a sharp decline in calling duration in June 2000.

4.4.3 Calls:

The mean number of calls at dawn in year 2000 was 29.19 calls per calling day (± S.E. = 1.65 calls, n = 203). The mean number of calls in the month of April was 21.07calls per day (± S.E. = 2.80 calls, n = 54), in the month of May, the mean number of calls per day was 44.22 (± S.E. = 2.05 calls, n = 94) and in the month of June it was 11.49 (± S.E. = 1.94 calls, n = 55) (Figure 4.9). The mean number of calls varied significantly across the months (df = 2, F = 59.34, $p<0.05$, One-way ANOVA) The number of calls varied significantly between all the three months ($p < 0.05$). In the year 2001, the mean number of calls at dawn was 32.60 (± S.E. = 1.28 calls, n = 261) per day. The mean number of calls in April was 10.57 (± S.E. = 1.47calls, n = 61), in the month of May it was 43.68 (± S.E. = 1.47 calls, n = 116) and in the month of June the mean number of calls was 33.32 (± S.E. = 1.99 calls, n = 84) (Figure 4.10). The mean number of the calls varied significantly across the months (df = 2, F = 82.01, p <0.05, One-way ANOVA). The mean number of calls heard was maximum in the month of May in both the years. The number of calls increased from April to May and decreased in June. In the year 2000, there was a rapid decrease in the calls in June as compared to the year 2001.

The mean number of calls heard in dusk 2000 per day were 18.09 calls (± S.E. = 1.05 calls, n = 194). The mean number of calls in April was 13.35 calls (± S.E. = 1.88 calls, n = 51), in May was 29.14 calls (± S.E. = 0.89 calls, n= 89) and in the month of June the mean number of the calls was 4.37 calls (± S.E. = 0.89 calls, n = 54) (Figure 4.11). The number of the calls varied significantly across the months (df = 2, F = 106.76, p <0.05, One-way ANOVA). The mean number of dusk calls in the year 2001 was 23.74 calls per day (± S.E. = 1.30 calls, n = 218). The mean number of calls heard in April was 10.55 (± S.E. = 2.04 calls, n = 65) while in the month of May the mean number of calls was 34.70 (± S.E. = 1.67 calls, n = 85) and for the month of June the mean number calls was 22.68 (± S.E. = 2.17 calls, n = 68) (figure 4.12). The mean of number calls varied across the months (df = 2, F = 39.41, p <0.05, One-way ANOVA). The mean number of calls was highest in the month of May in both the years. The number of calls increased till the month of May in both the years. The number of calls decreased rapidly in June 2000 while in June 2001 the decrease was not so rapid.

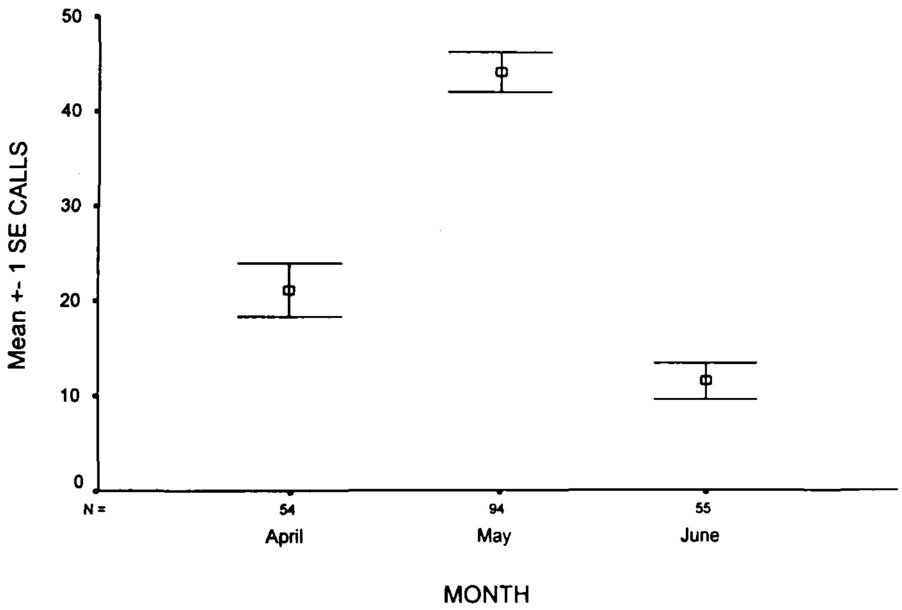


Figure 4.9 Mean number of the calls across the months at dawn in year 2000.

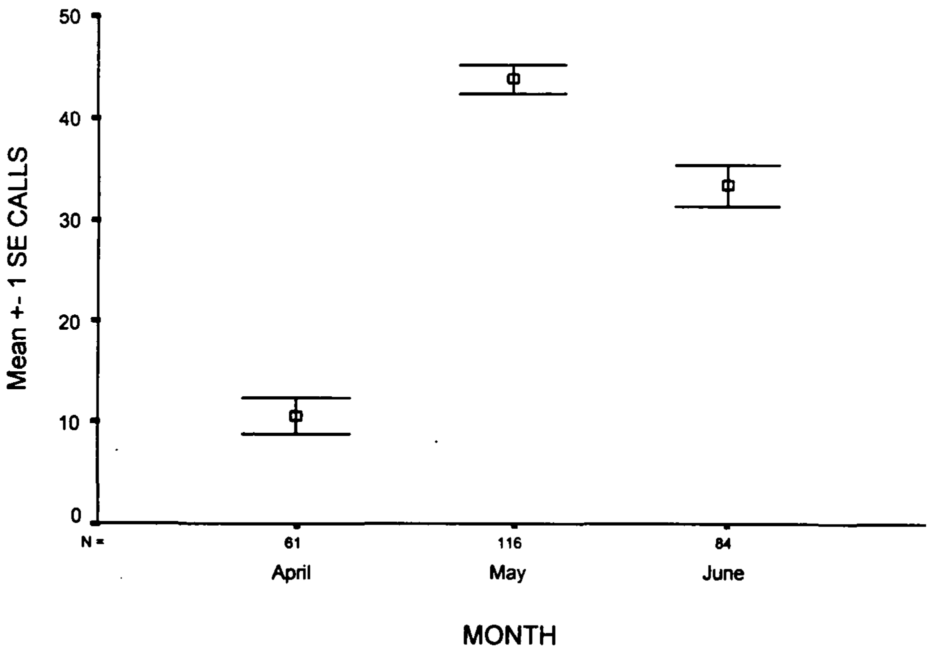


Figure 4.10 Mean number of calls across in the months at dawn in year 2001.

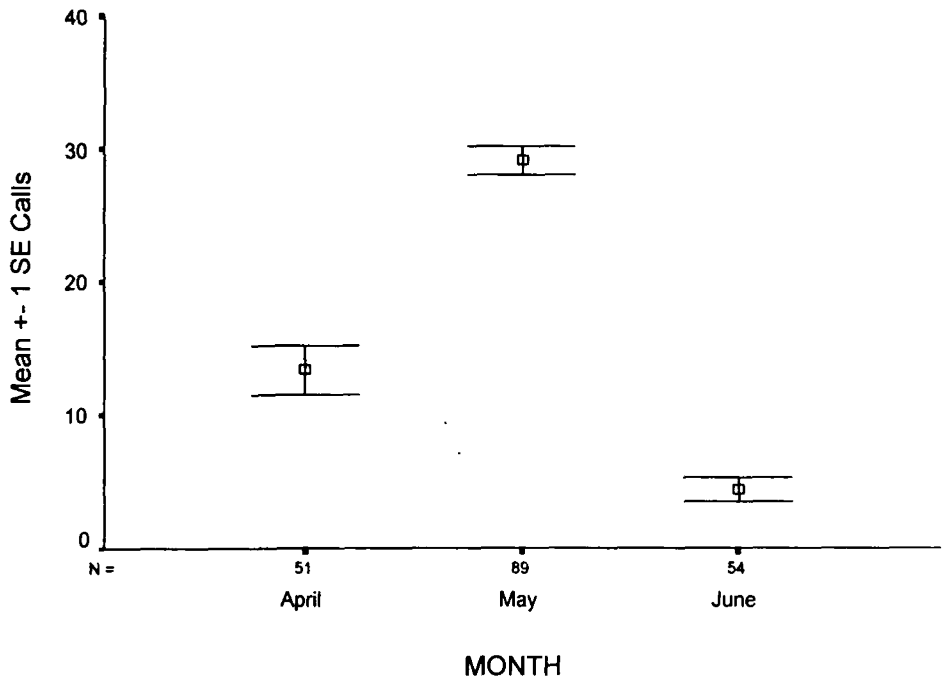


Figure 4.11 Mean numbers of calls across the months at dusk in year 2000

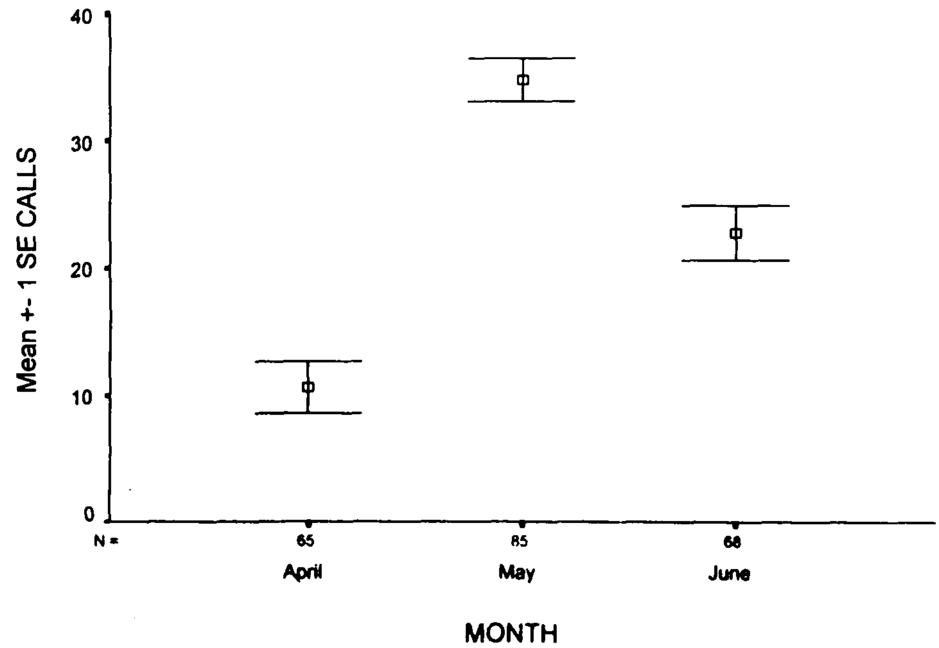


Figure 4.12 Mean number of calls across the months at dusk in year 2001

4.4.4 Comparisons between calling at dawn and dusk:

Comparisons were made between calling frequency and duration of calling at dawn and dusk. The calling frequency did not vary between dawn and dusk in year 2000 ($U = 8.28$, p = NS, Mann - Whitney U-Test) as well as in 2001 ($U = 0.185$, p = NS, Mann -Whitney U-test). The calling frequency did not vary between dawn ($U = 0.789$, p = NS, Mann - Whitney U-test) and dusk ($U = 0.782$, p =NS, Mann- Whitney U-test) between the years 2000 and 2001.The number of calls in the dawn did not vary significantly ($U = 24306.00$, $p = 0.124$, Mann-Whitney U-test) over the years while the duration of calling varied significantly in both the years ($U = 21330.500$, $p < 0.05$, Mann - Whitney U-test). The number of calls and their duration at dusk varied significantly between the years 2000 ($U = 17558.500$, $p < 0.05$, Mann - Whitney U-test) and 2001($U = 17544.00$, $p < 0.05$, Mann - Whitney U-test).

4.5 Discussion:

Much of the research on the status of Asian pheasants is based on call counts. Many workers (Blanford 1998, Ali and Ripley 1987, Gaston 1980) have suggested that Cheer pheasant is equally vocal at dusk as well as at dawn whereas Kaul (1989) and Young *et al.* (1987) suggested that the calling is much regular at dawn than at dusk. The dawn calling is a well know phenomenon in several bird species where the males are vocally active for sometime before sunrise and then stop or decrease it the rest of the day (Hinde 1952, Morton 1975, Mace 1987). This activity does not make any sense immediately as to why birds engage in a high energy activity like dawn calling, unless there is a strong selection pressure (Horsvfall). The "good-genes" hypothesis (Trivers 1972, Zahavi 1975 & 1977, Halliday 1978) of sexual selection assumes that females choose partners based on the signals that reliably indicate male's qualities, e.g. relative ability to sire fit offspring (Borgia 1979) or disease resistance (Hamilton and Zuk 1982).

The dawn calling duration in passerine birds has been well defined as a means of extra energy consumption, sperm competition and mate defense (Mance 1987). The territorial Great tit *Parus major* sings at dawn because it is relatively quiet during that part of the day (Kacelink and Kerbs 1983). Numerous studies have also documented that wind and air turbulence increase after dawn, which produce noises that attenuate the bird songs. Song production is also related to individual health and feeding conditions (Moller 1991), food availability and quantity (Searcy 1979, Greig-Smith 1983, Davies and Lundberg 1984, Gottlander 1987, Reid 1987, Strain and Mumme 1988), habitat and social constrains (Garson and Hunter 1979, Higgins 1979, Kroodsma 1982, Morton 1986, Santee and Bakken 1987). High breeding density might affect song production and structure resulting in counter singing in males (Lemon 1974, Kerbs *et al.* 1981, Falls 1985, Stoddard *et al.* 1992), which is often part of an elaborate vocal duel during male-male interactions (Kroodsma 1979, Simpson 1985). As the behavior and other activities change during the daytime or with the passage of time as in the case of Great tit, besides singing, the major competitive activity is feeding which is unprofitable in poor light at dawn (Kacelink and Kerbs 1983). In the case of Willow tits *Parus montanus*, dawn is said to be the best time to sing for mate defense, even if there are other functions. Singing would have low costs early in the morning and once the females emerge males would spend much of their time in mate guarding. Dawn calling by the Cheer pheasant could be linked to efficient transmission of message over a large area for marking their territories as well as defending them, which is probably unprofitable during the daytime as there are more chances of getting predated.

Many workers have emphasized that singing rate and song structure might reflect male phenotypic and genotypic quality. Females choose males that sing longer because they are likely to be in better condition and stronger than others (Beani and Dessi Fulgheri 1995). Males arrive at the breeding areas and establish their territories where they attract females by singing and displays. In the Cheer pheasant, this is the period of aggressive calling as it elicits calls from other cheer males in the area. Female choice is directly addressed to male qualities, which may be reflected in calling by the male.

The average mean calling duration of the cheer pheasant was less then seven minutes. The duration of the calling increased from April to May. The first calls given at the start of breeding season are meant to show their presence in the area, whereas increase in the calling duration and calls can be related to the appearance of female birds at the calling grounds and coinciding with egg laying. Similar phenomenon has also been observed in Barn swallow *Hirudo rustica* (Moller 1990) and emergence of females as in Willow tits (Welling *et al.* 1997).

In Kumoun, study of the calling behavior of Cheer pheasant was conducted from March to June and the peak calling duration was recorded in the month of April (Young *et al.*, 1987). In comparison, the peak duration of calling in Majathal – Harsand WLS was recorded in May in both the years 2000 and 2001. In Year 2000, there was a sharp decline in the calling duration in the month of June while it sustained in June 2001. This phenomenon was probably due to difference in the latitudes of the two sites. The latitude also affects the breeding (Hopkins 1938). Similar observations were reported for the Satyr tragopan at two different sites (Lelliot and Yonzon 1980, Picozzi 1987, Khalling *et al.*, 2002). Spring arrives later in higher latitudes; in North America the spring onsets about 4 or 5 days later for each northward shift 1° of latitude as it has an influence on the timing of breeding season of birds

(Hopkins 1938). This can also be attributed to the eastern longitudes where the monsoon starts much early as seen in Blyth tragopan (Ghose 1997) because of the early onset of rains. The breeding season in Himalayas coincides with the onset of monsoon and spring. During the monsoon, insect population is relatively higher than at other times of the year, which helps the birds to feed their younger ones whose energy demands are relatively higher (Kaul 1989).

Proximate and ultimate factors delimit the characteristic breeding season of any species (Skutch 1976). The breeding season of the Cheer pheasant starts from March and extends up to June (Ali and Ripley 1987). This period is characterized by an increase in the day length and the ambient temperature, which triggers the hormonal secretions in birds, sex hormones flow, gonads increase in size and proclamation of territories by males with the help of breeding calls (Thielcke 1976). The long winters and late springs may have widespread effect on the breeding birds (Gaston 1983). It is important to know the time of the year during which a species calls (Steward-Cox and Quinell 1989), so that status surveys can be undertaken to get reliable information on the density indices, which can be biased if done at the different months of the breeding season. The months of May and June were said to be important for the status surveys of pheasants in Himalayas (Gaston 1982). The calling durations were longer in April in Kumoun while maximum mean calling frequency was in June (Young *et al.*, 1987). In Majathal- Harsang WLS, both the calling duration as well as mean calling frequency was maximum in May in 2000 and 2001. This can be attributed to the differences in latitudes and due to the fact that in Kumoun the monsoon rains start much early than in Majathal-Harsang WLS.

The winter at Majathl – Harsang WLS was brief and spring started much earlier in 2000 as compared to 2001. This resulted in bird calling earlier in the year 2000 as compared to 2001. There was a delay in the onset of calling in 2001 as compared to 2000 but the number of calling days remained same in both the years. The increase in the duration of calling in year 2001 can probably be attributed to the delay in the onset of breeding season. The duration of calling and the number of calls increased with the advancement of the breeding season and ended with the onset of monsoon in the region. At the start of breeding season, the duration of calling was not pronounced probably because the males were establishing their territories. The calling peaked when the males were probably attracting females and this probably continued till the egg-laying period after which, there was a decline when the females were sitting on the eggs.

Birds respond to broadcasted calls (Gill 1989). A number of studies have been done by various workers on different species such as Cheer (Young *et al.,* 1987, Kalsi 1998), Malaysian peacock pheasant (McGowan 1992), Crested argus (Mamat and Yasak 1998) and Western tragopan (Islam and Crawford, 1996). Their results show that the birds do respond to the broadcasted calls. However, Lettiot (1981) was unsuccessful in using this method on the Cheer pheasant as he broadcasted the calls in the months between November to February and did not get any response. This was due to the fact that the cheer males do not have territories during the non-breeding season, and are not aggressive as there is no competition for the space and mates.

It is important to know the time of the year at which the birds are going to respond to the playback calls. In cheer, the playback calls can be used only at the time of breeding season. It is probably the best method that can be used to know the presence of cheer in a given area during breeding season in a short period of time with little man power, time and financial investments (Young *et al* 1987, Kalsi 1998, Ghose *et al.* 2003).

Chapter 5

Habitat Studies

5.1 Introduction

Habitat use by a species can be influenced by different factors. Studying the habitat use of species is the fundamental aspect of ecology. Characterization of the habitat features with which birds are associated is the foundation of life history, behaviour and evolutionary studies (Thorpe 1945). Habitat use indicates the "actual distribution of individuals" (Hutto 1985). Habitat use by species is affected by its density, densities of and interactions with other species, availability and abundance of resources and various biotic and abiotic factors (Block and Brennan 1993).

Animals might be expected to live in places where the physical and biotic factors produce the optimal conditions for them to feed, breed, cover and shelter (Partridge 1978, Rands 1988). These habitats, which are themselves a result of the geophysical events of the past, might have played a major role in shaping the evolution of the animal species that they support (Partridge 1978).

The study of the habitat use by a species is central to the aim to study community and niche relationship as well as to give an idea of conservation and management of population or habitat (Wiens and Rotenberry 1981.) The pioneering work on habitat selection in terms of speciation and adaptive radiations was done by Lack (1940, 1944).

The study of the habitat preferences of a species can be looked at in two stages. One is at the macrohabitat level and second at the microhabitat level. The macrohabitat level looks at the presence or absence of a species from an area or a particular habitat in comparison to the presence and absence from the other area or from other habitats (Evans & Hill 1991)

Microhabitat determines the finer distribution of a species within a particular macrohabitat type (Partridge 1978). Microhabitat structures have been extensively researched as a primary determinant of the species occurrence. The initial research on the avian ecology was focused on the microhabitat levels (MacArthur and MacArthur 1961, Cody 1985, James 1971, Roth 1976). The number of the habitat variables taken into consideration depends on the objectives of the study and on the attributes of the habitat to which the population under study is responding (Brennan 1987, McGowan 1992, Kaul 1989, Khaling 1998). Avian microhabitat structures have been researched extensively as the primary determinants of the occurrence of species.

The habitat studies on the pheasants are limited as compared to other avian families. The habitat studies have been done on Ring-necked pheasant in England and America (Hill and Roberts 1998a). There have been few studies on pheasants in Asia done by various workers. In India few detailed studies have been done on pheasants, which include Cheer pheasant (Kaul 1989) Himalayan monal (Sharma 1990, Kumar 1997, Ramesh 2003), Indian peafowl (Yasmeen 1995), White-crested kalij (Iqbal 1992, Ahmad 1994) Satyr tragopan (Khaling 1998, Hussain 2002, Ghosh 2004), Temminck's and Blyth's tragopans (Ghosh 2004) Western tragopan and Koklass pheasants (Ramesh 2003).

Himachal Pradesh represents the strong hold of the Cheer pheasant in India. No detailed study has been done on the Cheer pheasant in the state. Most of the work on Cheer pheasant in the state deals with distribution and abundance (Gaston *et al* 1981., Garson and Singh 1980, Kalsi 1998). The objectives of this study were:

1) To look at overall habitat use of the cheer pheasant at macrohabitat level.

2) To look at the habitat utilization at macro level in different seasons.
3) To study overall microhabitat of Cheer pheasant.
4) To study microhabitat of Cheer pheasant over seasons.

5.2 Methods:

The study period was divided into three seasons: Post-breeding (October to December) Winter (January to March) and Breeding season (April to June).

5.2.1 Quantification of the habitat use:

Seven habitats were identified in the study area according to the composition and structure of the vegetation. Due to undulating terrain, laying of the transects was not possible. Trail monitoring and random searches were made to encounter the Cheer pheasants. The time effort in each habitat stratum was noted and a correction was applied taking into account the area of each habitat stratum. Each sighting was considered an independent sighting. Likewise, indirect evidences such as droppings, feathers and calls were also considered. After an observation, indirect evidences such as droppings and feathers were removed so that they were not counted again. Ten random plots were laid in each habitat stratum in the last week of each month and these plots were treated as random plots.

5.2.2 Quantification of the habitat availability:

Restricted stratified random sampling was used (Kerbs 1978) in the selected habitats strata (Muller-Dombois and Ellenberg 1974). Sampling for the vegetation parameters was done in circular plots of 0.05 hectare area. Landscape assessment was done visually in order to stratify the habitat at each plot. Various parameters of the habitat were recorded at the site. The data on trees (girth at breast height (GBH) > 10 cm) and saplings (<1 m tall and < 10 cm GBH) was collected. All the trees within the circular plot were counted by species and their GBH was measured. Canopy cover (%) was estimated by taking 20 + or - readings through a sighting tube (diameter = 5cm) for the presence or absence of green leaves. The tube was directed vertically upwards and sightings were made by taking alternate steps along the diameter of the circle (Bibby *et al.* 1992). Canopy height was measured visually.

Within each circular plot, one 4x4 meter quadrat (Muller-Dombois and Ellenberg 1974) was marked randomly for sampling the shrubs. Shrub cover (%) was estimated at three heights: 0.5m, 1m, 1.5m, by counting the number of covered squares (each square = 5x5 cm) of a 30 x 50 cm chequer-board at a distance of 5 m (Bibbly *et al.* 1992). Readings were taken by holding the density board at four corners of the quadrate and mean values were calculated. A heterogeneity index (HI) for shrub cover was calculated by the formula HI = Σ (maximum height - minimum height)/ mean height (Bibby *et al.* 1992).

Data on grass cover was collected in two randomly located 1x1 m quadrants (Muller-Dombois and Ellenberg 1974) marked within the circular plot, and mean values were calculated. Grass cover (%) was estimated along each 1x1 quadrant by taking 20 + or - readings through a sighting tube (diameter =3cm) held at the waist height for the presence or absence of ground cover, respectively. Ground cover height was measured at four corners of each 1x1 m quadrat with a scale. A heterogeneity index (HI) for ground cover was calculated by the formula HI = Σ (maximum height - minimum height)/ mean height (Bibby *et al.* 1992).

5.3 Data analysis:

There are a number of statistical methods; both multivariate and univariate used in the analyses of avian habitat use data. Their application depends upon the nature of the study and sampling design.

All percent variables were arcsine transformed while the non-proportional variables were transformed to $X' = \text{Log}\ (X+1)$ for statistical analyses (Sokal and Rohlf 1981). The data were not clubbed together as there were significant differences between the habitat variables.

Descriptive statistics were calculated for the macro- and microhabitat variables. The means of macro- and microhabitat variables at cheer and random plots were compared by one-way analysis of variance (ANOVA) between years and seasons.

Habitat and community studies are multidimensional in nature and it and it is desirable to use multivariate statistical procedures to identify variables that may be useful for assessing the habitat (Rextad *et al.* 1988). To find the differences at the microhabitat level, multivariate ordination was used. Principal Component Analysis (PCA) was done between the bird plots and the random plots across the seasons. PCA is a multivariate statistical technique that reduces the dimensionality by deriving few uncorrelated components from a set of original variables. All the analyses were performed using the software package SPSS ver. 11 for windows. Bonferroni Confidence Intervals were constructed following Neu *et al.* (1974) and Byers and Steinhorst (1984) to determine the habitat preferences by comparing the proportion of observed (pi) with the proportion of expected (pi_o) usage each habitat. Software program PREFER (Prasad and Gupta 1992) was used to compute the confidence intervals, which was based on calculating chi-square and then constructing the confidence intervals using the Bonferroni statistics. Simultaneous Bonferroni Confidence Intervals were constructed for actual proportion of usage (pi).

5.4 Results:

5.4.1 Macrohabitat:

Seven habitat types were available for the Cheer pheasant in Majathal-Harsang Wildlife Sanctuary. The habitat types were quantified in the terms of their availability. The seven habitat types in the study area were Dense Pine, Open Pine, Oak, Scrub, Grassland, Degraded and Cultivated Fields.

1) Dense pine: This habitat category consisted of pure strands of young plantations of Cheer Pine *Pinus roxcburghii.* Tree density was 50.26 trees per hectare.The mean canopy cover was 55.29 percent. The shrub species present were *Aechmanthera pedata*, *Hypericum oblongifolium*, *Salvia plebeja*, *Inula cappa* and *Berberis aristata*. The mean shrub height was 0.94 meter mean Ground cover was 53.29 percent while the mean ground height was 0.19 meter.
2) Open pine: This habitat stratum consisted of pure strands of mature Chir pine trees. The tree density was 21.19 trees per hectare. The mean canopy cover was 42. 55 percent. The shrub species present in this habitat were *Berberis aristata*, *Dodoenea viscose* and *Rubus ellipticus*. The mean shrub height was 0.62 meter whilemean ground cover was 72.15 percent. The mean ground height was 0.46 meter.
3) Oak: This habitat was dominated with Ban Oak *Quereus leucotrichophora* and had other species like *Ficus articulata, Ficus nerriforlia, Rufus continus, Rhus wallichii, Rhus punjabesis, Glochidion velutinum* and *Prunus paddam*. The tree density was 46.07 trees per hectare. The mean canopy cover was 78.78 percent. The major shrub species were *Aechmanthera pedata*, *Hypericum oblongifolium* and *Berberis aristata*.The mean shrub height was 0.38 meter. The mean ground cover was 32.51 percent and mean ground height was 0.17 meter.
4) Scrub: Few strands of Cheer Pine were present. The mean tree density was 1.20 trees per hectare. The mean canopy cover was 2.90 percent. The shrub species present were *Hypericum oblongifolium, Berberis aristata, Dodonaea viscosa*, *Rubus ellipticus* and *Hamiltonia suaveolens*. The mean shrub height was 1.10 meter. The mean ground cover was 63.71 percent while the ground height was 0.215 meter.
5) Grassland: There were vast areas with good grass cover and few trees of *Pinus roxburghii, Quereus leucotrichophora* and *Bauhinia purpurea*. The tree density was 2.42 trees per hectare.The scrub species present were *Berberis aristata*, *Indigofera hetromella* and *Woodfordia fructicosa*. The

mean ground cover was 84.73 percent and mean ground height was 0.57 meter.

6) Degraded: The degraded habitat had very few trees of *Quereus leucotrichophora* and *Sterculia villosa*. The mean tree density was 0.22 trees per hectare. The mean canopy cover was 0.61 percent. The habitat consisted of high density of *Euphorbia royalena.* The shrub species present were *Berberis aristata, Indigofera hetromella* and *Woodfordia fructicosa.* The mean shrub height was 1.52 meter. The mean ground cover was 34.06 percent while the mean ground cover height was 0.14 meter.
7) Cultivated fields: This habitat stratum consisted of agricultural fields near the villages. The main crops were maize, wheat and mustard.

5.4.2. Aspect:

Most of the cheer plots were on the south-west aspect which constituted 52 percent of the total cheer plots, while on the north-east 38 percent of the cheer plots were found. In north-west aspect had eight percent of the cheer plots while south-east aspect had only two percent of the cheer plots. In all seasons most of the plots were on the south-west aspect (Figure 5.1).

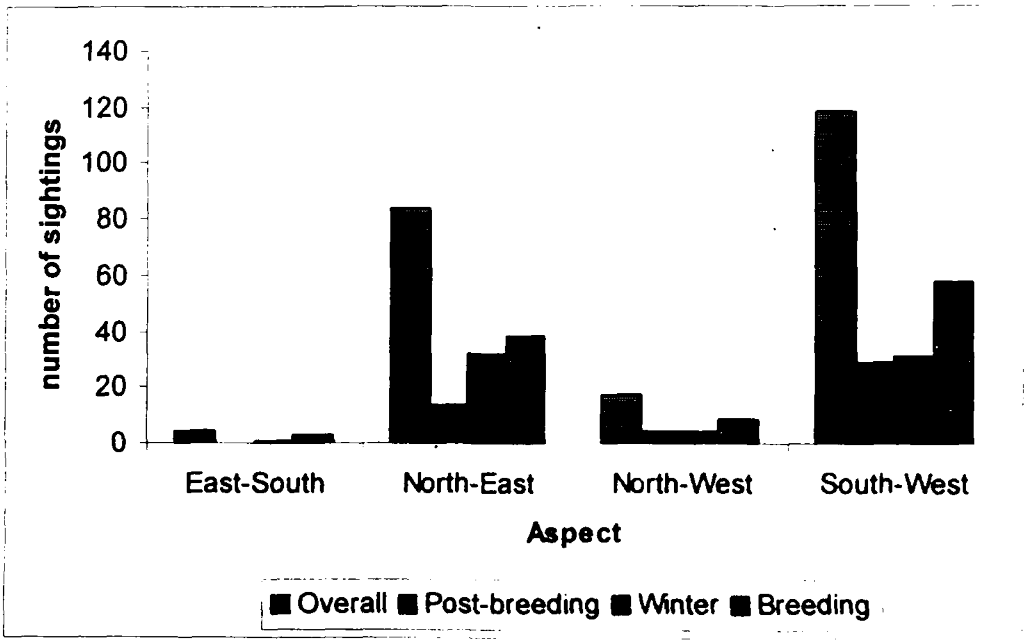


Figure 5.1 Number of sightings at different aspect during the study

5.4.3 Habitat availability / preference:

A total of 225 birds plots were studied. The species preferred open pine, scrub and grassland more then the expected while oak, degraded and cultivation was used less then the expected, while dense pine was used in the proportion to its availability (Table 5.1).

Table 5.1 Overall habitat availability – utilization of different vegetation type by Cheer pheasant in Majathal-Harsang WLS.

Habitat type	Relative Area	Expected Usage	Observed Usage	Confidence Intervals
Dense Pine	10	22	33	0.083 - 0.210
Open Pine	10	22	48	0.140 – 0.287*
Oak	20	45	1	0.00 – 0.016**
Scrub	20	45	77	0.257 – 0.427*
Grassland	20	45	66	0.212 – 0.375*
Degraded	10	22	0	0.000 - 0.000**
Cultivation	10	22	0	0.000 – 0.000**

Z = 2.689,

***Used more than expected,**

**** Used less than expected**

5.4.4 Post breeding season:

The total number of bird plots in this season was 60. The scrub and grassland were used more than the expected while the dense pine, oak, degraded and cultivation were used less the excepted while open pine was used in the proportion to its availability (Table 5.2).

Table 5.2 Availability – utilization of different habitat types by Cheer pheasant during post breeding season.

Habitat type	Relative Area	Expected Usage	Observed Usage	Confidence Intervals
Dense Pine	10	4.9	1	0.000 – 0.061**
Open Pine	10	4.9	8	0.058 – 0.269
Oak	20	9.8	0	0.000 – 0.000**
Scrub	20	9.8	19	0.249 – 0.527*
Grassland	20	9.8	21	0.287 – 0.570*
Degraded	10	4.9	0	0.000 – 0.000**
Cultivation	10	4.9	0	0.000 - 0.000**

Z = 2

***Used more than expected.**

**** Used less then expected**

5.4.5 Winter season:

The total number of the bird plots recorded in this season was 68. The open and dense pine habitats were used more than excepted while degraded and cultivation were used less than the excepted. The scrub and the grassland habitats were used in portion to their availability (Table 5.3).

Table 5.3 Availability – utilization of different habitat types by Cheer pheasant during winter season.

Habitat type	Relative Area	Expected Usage	Observed Usage	Confidence Intervals
Dense Pine	10	6.8	15	0.120 – 0.321*
Open Pine	10	6.8	19	0.171 – 0.388*
Oak	20	13.6	1	0.000 – 0.044**
Scrub	20	13.6	16	0.132 – 0.338
Grassland	20	13.6	17	0.145 – 0.355
Degraded	10	6.8	0	0.000 – 0.000**
Cultivation	10	6.8	0	0.000 – 0.000**

(Z=2)

***Used more than expected.**

**** Used less then expected**

5.4.6 Breeding season:

The total number of bird plots recorded in the season was 108. The open pine, scrub and grassland were used more than the excepted while oak, degraded and cultivation were used less than accepted. The dense pine habitat was used in the proportion to its availability (Table 5.4).

Table 5.4 Availability – utilization of different habitat types by Cheer pheasant during breeding season.

Habitat type	Relative Area	Expected Usage	Observed Usage	Confidence Intervals
Dense Pine	10	10.8	5	0.000 – 0.101
Open Pine	10	10.8	23	0.107 – 0.310*
Oak	20	21.6	0	0.000 – 0.000**
Scrub	20	21.6	45	0.289 – 0.544*
Grassland	20	21.6	35	0.203 – 0.455*
Degraded	10	10.8	0	0.000– 0.000 **
Cultivation	10	10.8	0	0.000 – 0.000**

Z = 2.689

***Used more than expected.**

**** Used less then expected**

5.4.7 Descriptive statistics:

5.4.7.1 Macrohabitat

First year:

There were differences between all the landscape habitat variables between cheer plots and the random plots (Table 5.5). The forest cover, terracing, and bare ground were more in random plots as compared to the cheer plots while scrub and grass were having higher vales in cheer plots as compared to random plots (Fig 5.2).

Analysis of habitat data on landscape level was also done season-wise. In post breeding season, forest cover, grass cover and scrub cover varied significantly between cheer and random plots (Table 5.6), while there were no differences between terracing and slope (Figure 5.3). In winter season, forest cover, grass cover, scrub cover and slope varied significantly between the random plots and the cheer plots (Table 5.7) while terracing and bare ground did not varied significantly between the random and cheer plots. (Figure 5.4). In breeding season, landscape variables also varied significantly between cheer and random plots. There were differences between all landscape characteristics between the random plots and cheer plots Table (5.5).

Table 5.5 Landscape habitat variables of random and cheer plots in the study area in first year.

Variables	Random plots Mean ± (S.E.)	Cheer plots Mean ± (S.E.)	F*	Sig.
Forest	32.73(± 1.287)	9.983 (± 1.479)	37.589	0.000
Terracing	8.208 (± 1.093)	0.000 (± 0.000)	6.841	0.009
Grass	23.325 (± 1.232)	45.136 (± 3.197)	34.642	0.000
Scrub	17.508 (± 0.978)	36.917 (± 3.126)	41.599	0.000
Bare ground	17.908 (± 1.064)	7.945 (± 0.486)	10.607	0.001
Slope	47.033 (± 0.205)	48.849 (± 0.928)	7.310	0.007

* One-way ANOVA, Degrees of freedom (df) = 1

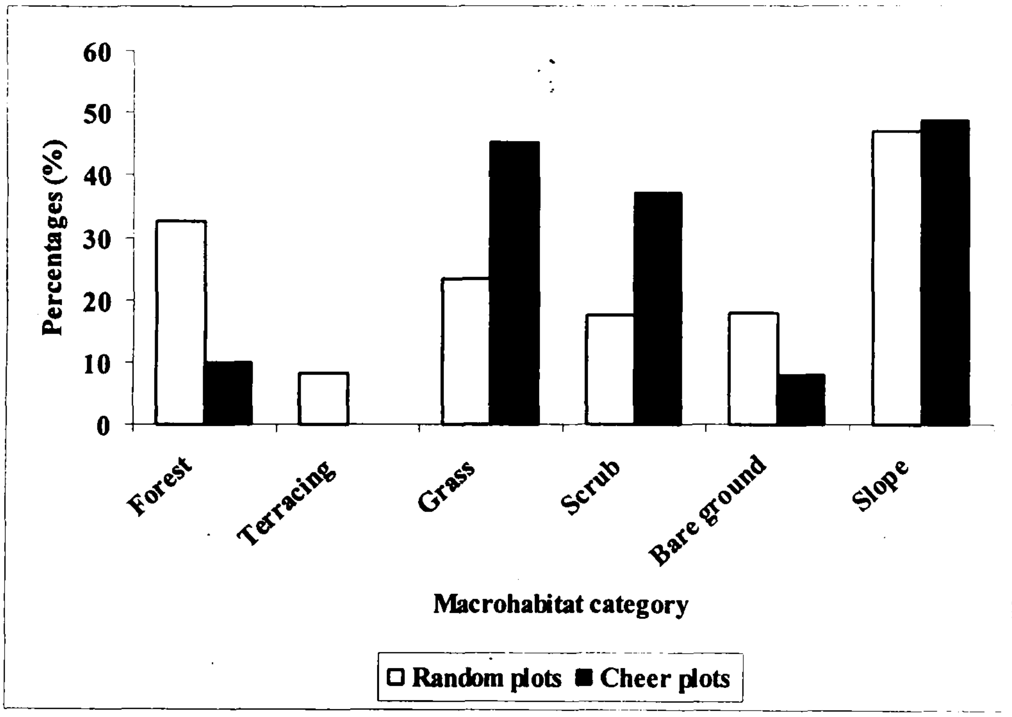


Figure 5.2 Landscape habitat variables of random and cheer plots in first year

Table 5.6 Landscape habitat variables of random and cheer plots in the study area in post breeding season in first year.

Variables	Random plots Mean (S.E.)	Cheer plots Mean (S.E.)	F*	Sig.
Forest	32.722 (±2.370)	5.340 (± 1.489)	9.276	0.003
Terracing	5.25 (± 1.627)	0.000 (± 0.000)	0.753	0.386
Grass	25.638 (± 2.443)	59.230 (± 10.029)	12.560	0.000
Scrub	13.472 (± 1.690)	30.769 (± 9.816)	6.466	0.012
Bare ground	22.944 (± 2.347)	3.461 (± 1.430)	4.942	0.027
Slope	47.97 (± 0.333)	50.384 (±1.323)	3.493	0.063

* One-way ANOVA, Degrees of freedom (df) = 1

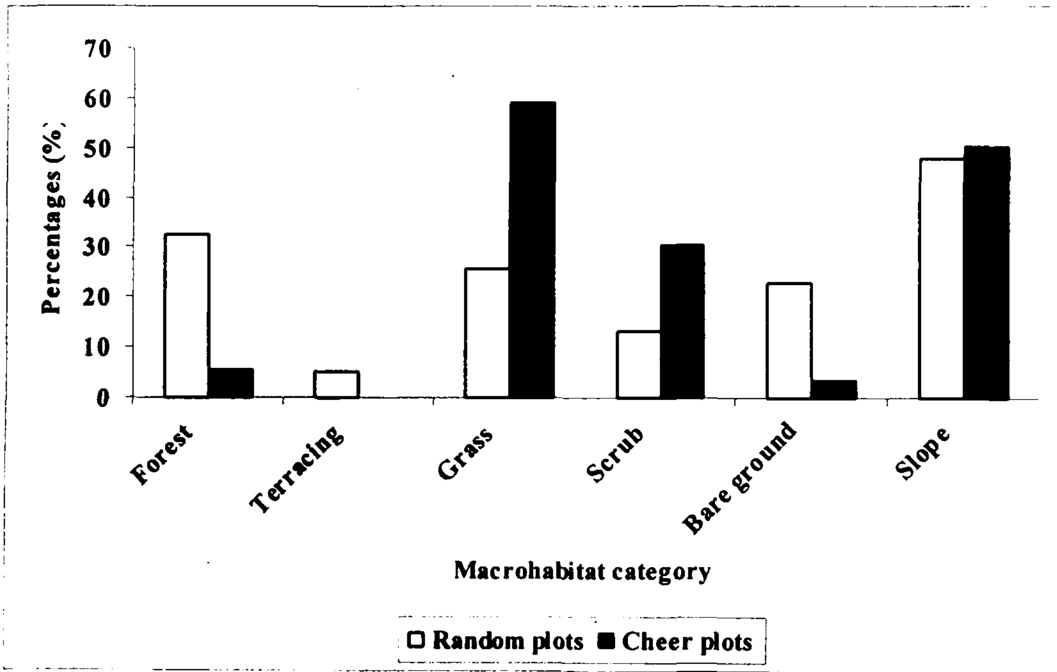


Figure 5.3 Landscape habitat variables between random and cheer plots in post breeding season in first year.

Table 5.7 Landscape habitat variables of random and cheer plots in the study area in winter season in first year.

Variables	Random plots Mean (S.E.)	Cheer plots Mean (S.E.)	F*	Sig.
Forest	33.444 (± 2.377)	14.688 (± 4.365)	5.375	0.021
Terracing	10.194 (± 2.176)	0.000 (± 0.000)	1.92	0.165
Grass	22.472 (± 2.003)	41.875 (± 6.628)	7.678	0.006
Scrub	18.361 (± 1.689)	35.000 (± 6.208)	7.803	0.006
Bare ground	14.639 (± 1.475)	8.438 (± 1.092)	1.559	0.213
Slope	46.750 (± 0.362)	49.375 (± 1.434)	4.164	0.043

* One-way ANOVA, Degrees of freedom (df) = 1

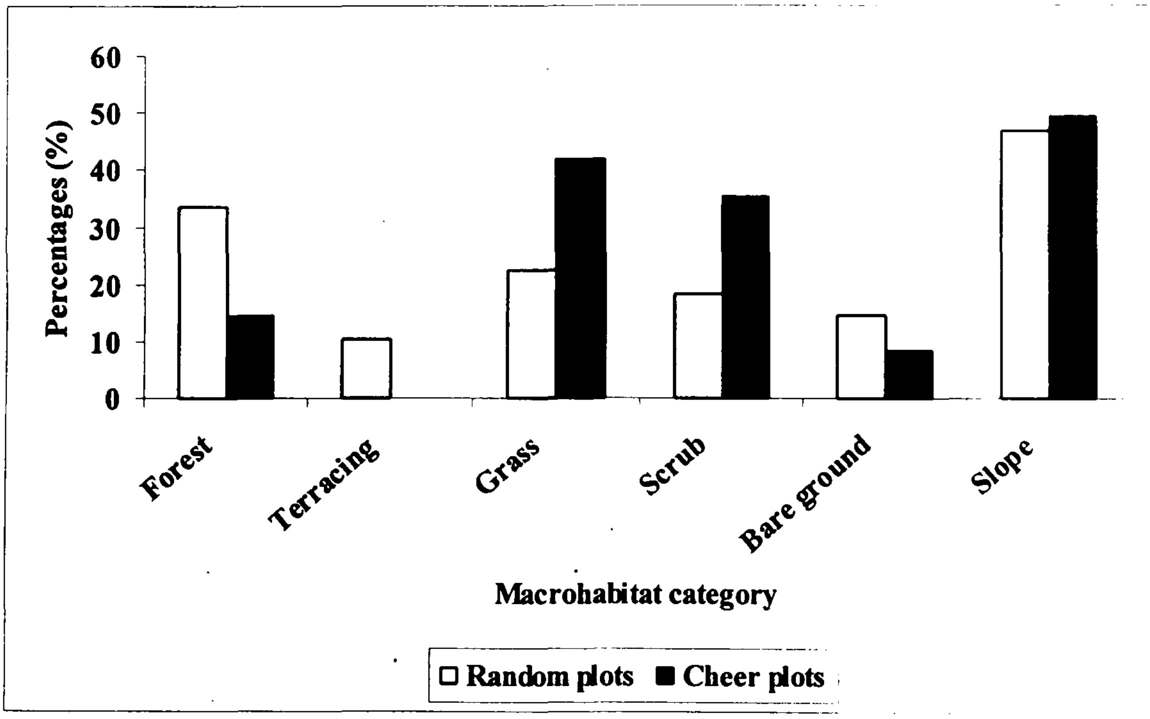


Table 5. 4 Landscape habitat variables between random and cheer plots in winter season in first year.

Table 5.8 Landscape habitat variables of random and cheer plots in the study area in breeding season in first year.

Variables	Random plots Mean (S.E.)	Cheer plots Mean (S.E.)	F*	Sig.
Forest	31.159 (± 2.322)	9.318 (± 1.778)	22.5190	0.000
Terracing	6.667 (± 1.864)	0.000 (± 0.000)	3.115	0.079
Grass	20.694 (± 2.249)	42.159 (± 3.589)	19.297	0.000
Scrub	19.944 (± 1.927)	39.432 (± 3.726)	20.429	0.000
Bare ground	20.583 (± 2.079)	9.091 (± 0.407)	7.425	0.007
Slope	46.500 (± 0.415)	48.205 (± 1.400)	2.464	0.118

* One-way ANOVA, Degrees of freedom (df) = 1

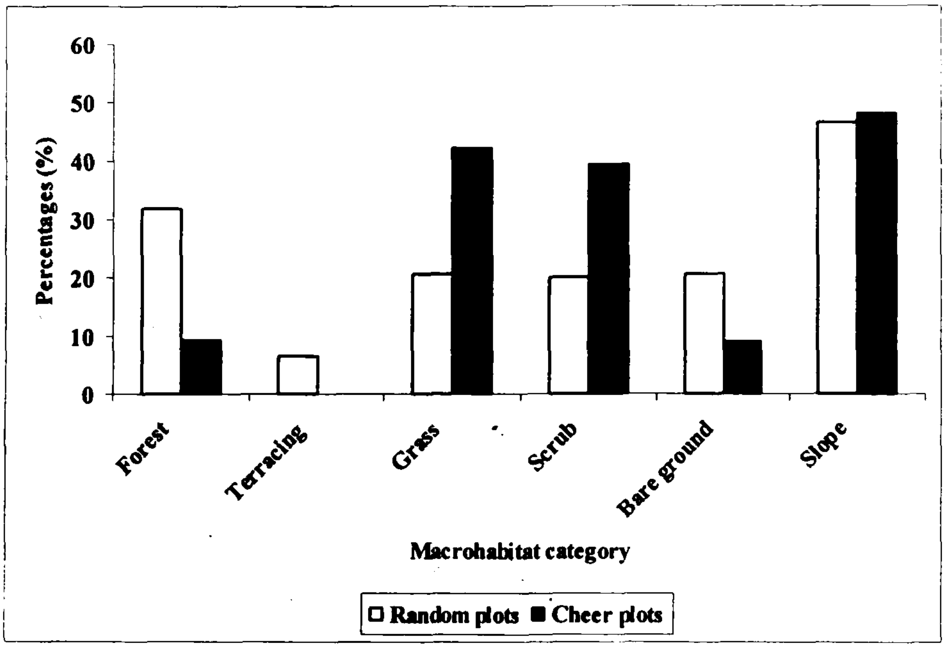


Table 5. 5 Landscape habitat variables between random and cheer plots in breeding season in first year.

Second year:

The landscape variables varied significantly between random and cheer plots (Table 5.9). The forest cover, terracing, and bare ground were more in random plots as compared to cheer plots, while grass cover, scrub cover, and slope was more in the cheer plots than in random plots (Fig 5.6).

In post-breeding season the landscape also varied significantly between cheer and random plots (Table 5.10). There was significant difference in slope between cheer and random plots (Fig 5.7). In winter season, the landscape variables varied significantly between the cheer and the random plots (Table 5.11). The forest cover, terracing, and bare ground cover were more in the random plots as compared to cheer plots while scrub cover, grass cover and slope were more in the cheer plots as compared to random plots (Figure 5.8). In breeding season, landscape variables also varied significantly (Table 5.12). The forest cover, terracing, grass cover, scrub cover and the bare ground varied significantly while in slope there was no difference in the usage between the cheer and the random plots (Figure 5.9).

Table 5.9 Landscape habitat variables of random and cheer plots in the study area in second year.

Variables	Random plots Mean (S.E.)	Cheer plots Mean (S.E.)	F*	Sig.
Forest	31.407 (± 1.423)	14.933 (± 1.435)	38.054	0.000
Terracing	4.886 (± 0.869)	0.167 (± 0.167)	9.184	0.003
Grass	23.500 (± 1.353)	45.700 (± 2.242)	66.335	0.000
Scrub	19.386 (± 1.016)	28.133 (± 2.000)	16.802	0.000
Bare ground	19.240 (± 1.190)	7.633 (± 0.362)	29.432	0.000
Slope	48.146 (± 0.293)	49.900 (± 0.618)	7.811	0.005

* One-way ANOVA, Degrees of freedom (df) = 1

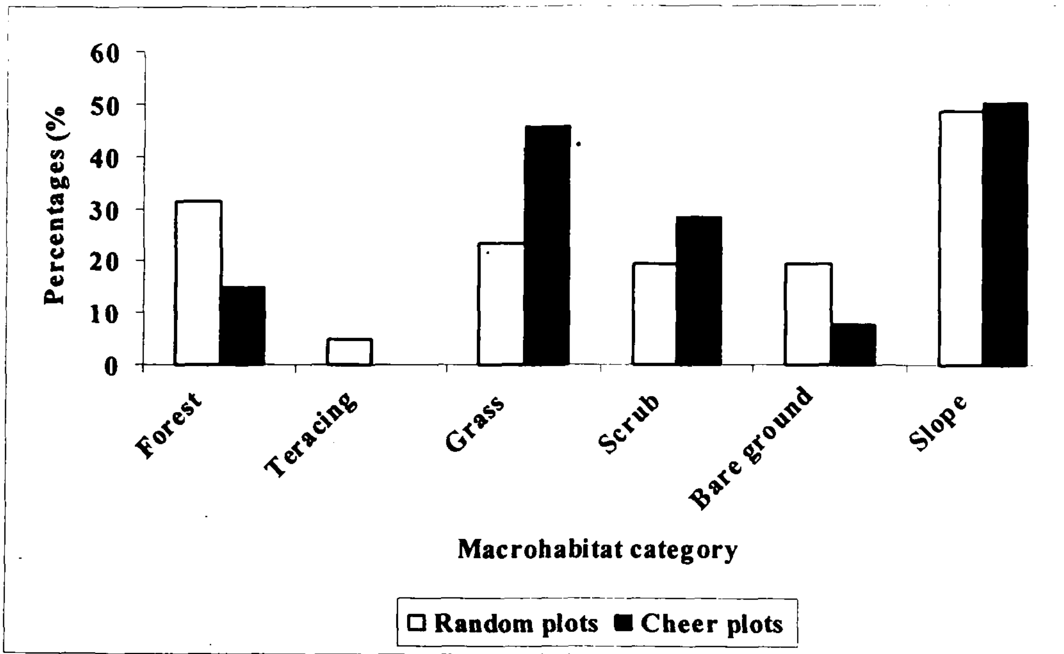


Figure 5.6 Landscape habitat variables of random and cheer plots in second year.

Table 5.10 Landscape habitat variables of random and cheer plots in the study area in post-breeding season in second year.

Variables	Random plots Mean (S.E.)	Cheer plots Mean (S.E.)	F*	Sig.
Forest	32.250 (± 3.000)	10.147 (± 2.189)	16.052	0.000
Terracing	0.001 (± 0.000)	0.000 (± 0.000)		0.000
Grass	23.709 (± 2.970)	54.853 (± 5.330)	24.746	0.000
Scrub	18.375 (± 2.070)	29.559 (± 5.555)	5.270	0.023
Bare ground	24.625 (± 3.179)	5.411 (± 0.712)	10.226	0.002
Slope	46.917 (± 0.464)	48.382 (± 0.937)	2.625	0.107

* One-way ANOVA, Degrees of freedom (df) = 1

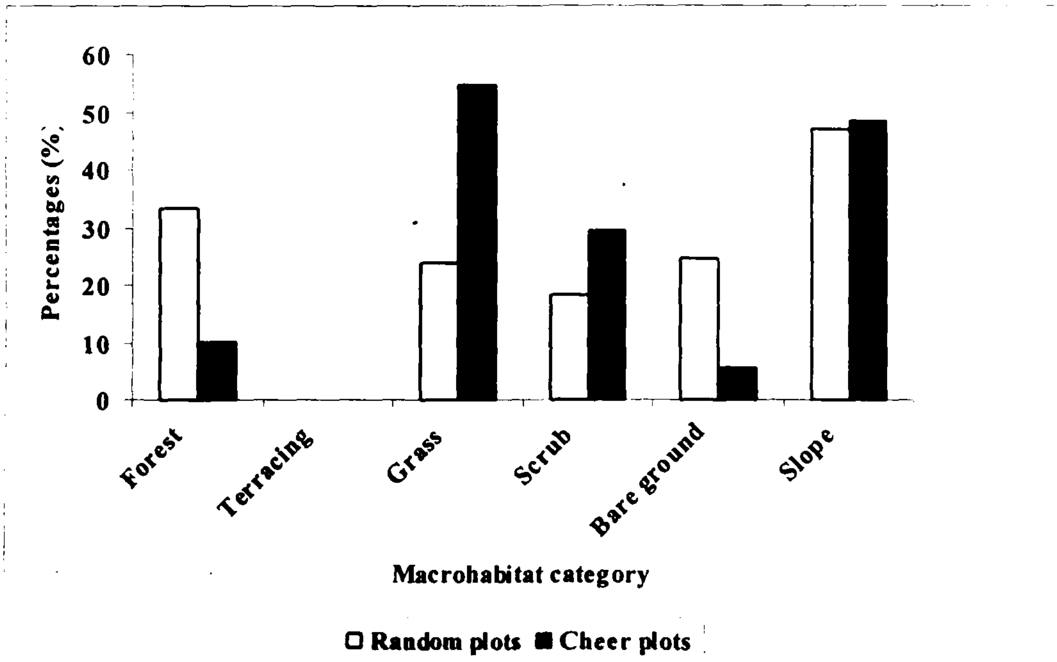


Figure 5. 7 Landscape habitat variables of random and cheer plots in post breeding season in second year.

Table 5.11 Landscape habitat variables of random and cheer plots in the study area in winter season in second year.

Variables	Random plots Mean (S.E.)	Cheer plots Mean (S.E.)	F*	Sig.
Forest	30.612 (± 2.266)	15.577 (± 2.668)	11.383	0.001
Terracing	8.501 (± 1.809)	0.481 (± 0.481)	5.628	0.019
Grass	23.639 (± 2.156)	41.827 (± 4.169)	15.674	0.000
Scrub	18.167 (± 1.566)	25.192 (± 3.429)	4.278	0.040
Bare ground	19.194 (± 1.666)	7.981 (± 0.676)	12.869	0.000
Slope	48.194 (± 0.464)	51.346 (± 1.091)	9.132	0.003

* One-way ANOVA, Degrees of freedom (df) = 1

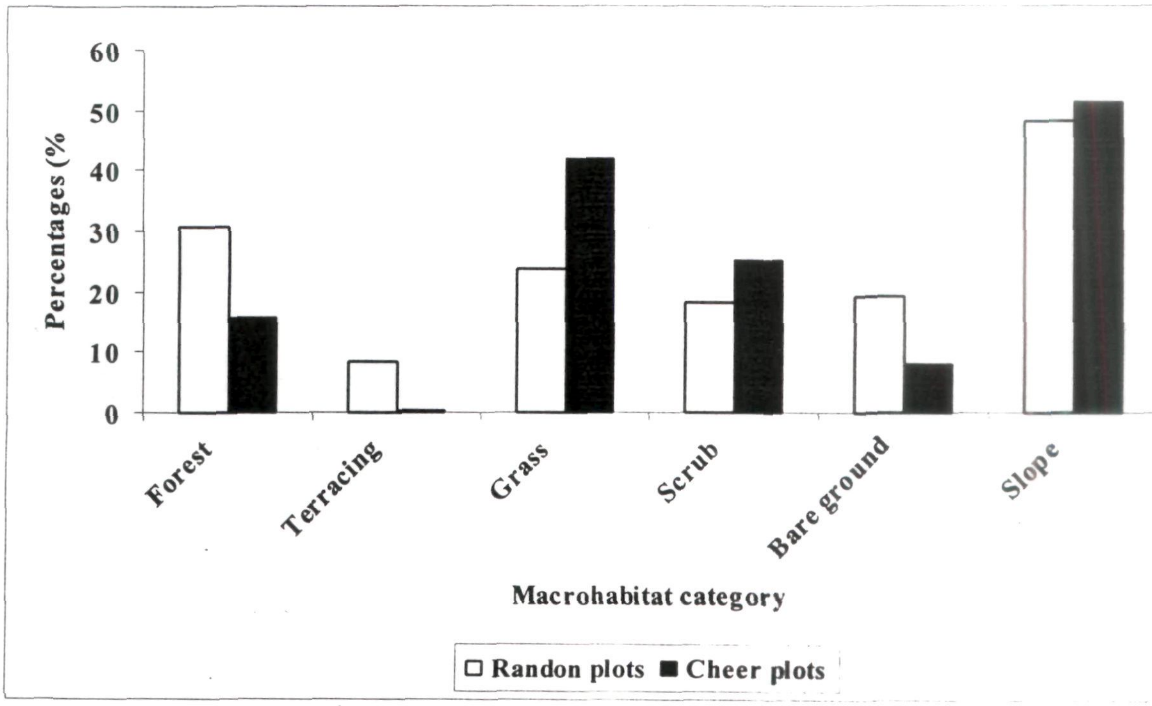


Figure 5.8 Landscape habitat variables of random and cheer plots in winter season in second year.

Table 5.12 Landscape habitat variables of random and cheer plots in the study area in breeding season in second year.

Variables	Random plots Mean (S.E.)	Cheer plots Mean (S.E.)	F*	Sig.
Forest	30.935 (± 2.306)	16.953 (± 2.268)	11.694	0.001
Terracing	4.529 (± 1.396)	0.000 (± 0.000)	3.732	0.055
Grass	23.223 (± 2.122)	43.984 (± 2.753)	28.033	0.000
Scrub	21.223 (± 1.728)	29.766 (± 2.557)	6.718	0.010
Bare ground	15.694 (± 1.634)	8.516 (± 0.481)	6.774	0.010
Slope	48.917 (± 0.563)	49.531 (± 1.019)	0.300	0.585

* One-way ANOVA, Degrees of freedom (df) = 1

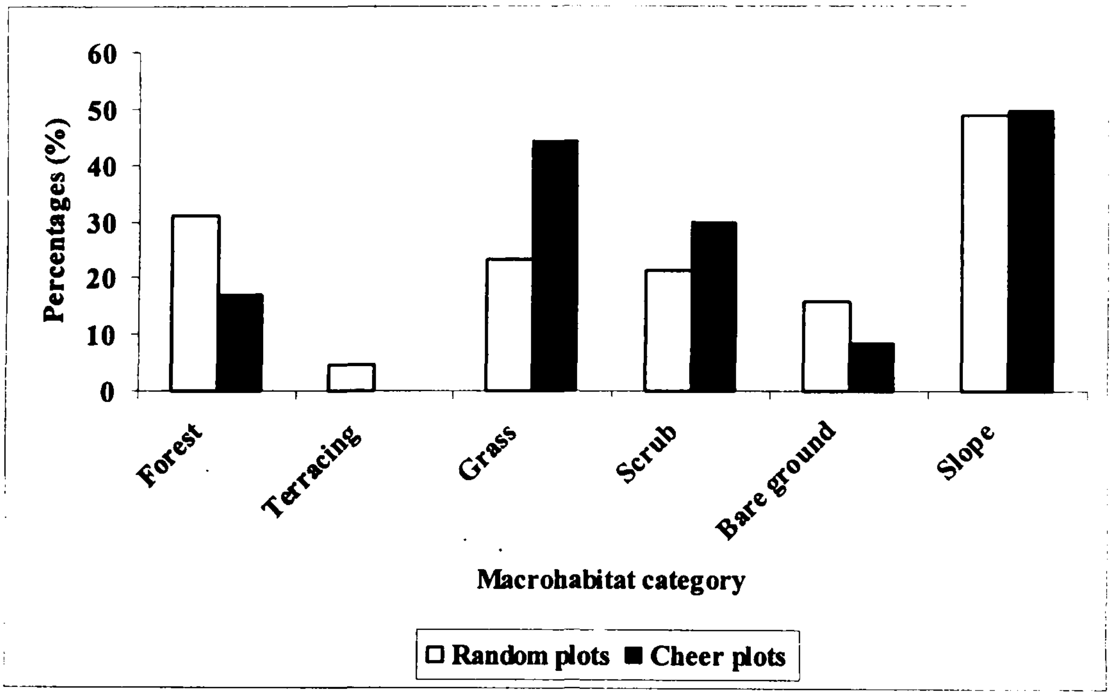


Figure 5.9 Landscape habitat variables of random and cheer plots in breeding season in second year.

5.4.7.2 Microhabitat

First year:

The data on the microhabitat was collected for cheer and the random plots. Some variables varied significantly between random and cheer plots (Table 5.13). The number of trees, canopy cover, number of saplings and shrub cover at 1.5 meter were more in random plots as compare to cheer plots while GBH of trees, mean height of tree, number of shrub species, shrub cover at 0.5 meter, shrub cover at 1 meter, shrub height, shrub heterogeneity, ground cover and ground cover height were more in cheer plots as compared to random plots (Figure 5.10 & 5.11).

In post breeding season, the data also varied significantly between cheer and random plots (Table 5.14). The number of trees, canopy cover, shrub cover at 1.5 meter, ground cover heterogeneity was more in random plots where as tree height, GBH of trees, number of shrub species, shrub cover at 0.5 meter, shrub cover at 1 meter, shrub height, shrub heterogeneity, ground cover, ground cover height and number of saplings was more in cheer plots as compared to random plots (Figure 5.12 & 5.13).

In winter season, the data obtained on the micro habitat variables between random and cheer plots varied significantly (Table 5.15). The total number of trees, canopy cover and shrub heterogeneity was more in random plots as compared to cheer plots while tree height, GBH of trees, number of shrub species, shrub cover at 0.5 meter, shrub cover at 1 meter; shrub height were more in cheer plots as compared to random plots (Figure 5.14 & 5.15).

Table 5.13 Microhabitat variables at random and cheer plots in first year.

Variables	Random plot Mean ± S.E.	Cheer plot Mean ± S.E.	F*	Sig.
Number of trees	8.019 (± 0.540)	2.617 (± 0.421)	14.360	0.000
Tree height	3.892 (± 0.219)	5.007 (± 0.558)	3.318	0.069
GBH	38.130 (± 2.149)	52.142 (± 5.569)	5.413	0.020
Number of sapling species	0.305 (± 0.022)	0.302 (± 0.057)	0.003	0.956
Number of sapling	0.991 (± 0.081)	0.823 (± 0.185)	0.564	0.453
Canopy cover	22.908 (± 1.435)	13.014 (± 1.686)	6.712	0.010
Number of shrub species	1.920 (± 0.075)	3.479 (± 0.200)	54.096	0.000
Shrub cover at 0.5 meter	0.595 (± 0.020)	0.909 (± 0.023)	34.944	0.000
Shrub cover at 1 meter	0.294 (± 0.018)	0.456 (± 0.045)	10.910	0.001
Shrub cover at 1.5 meter	0.199 (± 0.052)	0.185 (± 0.042)	0.009	0.923
Shrub height	0.703 (± 0.207)	1.052 (± 0.053)	21.865	0.000
Shrub heterogeneity	0.098 (± 0.006)	0.160 (± 0.015)	14.331	0.000
Ground cover	49.417(± 1.480)	69.726 (± 2.154)	26.172	0.000
Ground cover height	0.183 (± 0.009)	0.440 (±0.053)0	65.740	0.000
Ground cover heterogeneity	0.158 (± 0.010)	0.094 (± 0.013)	6.140	0.014

* One-way ANOVA, Degrees of freedom (df) = 1

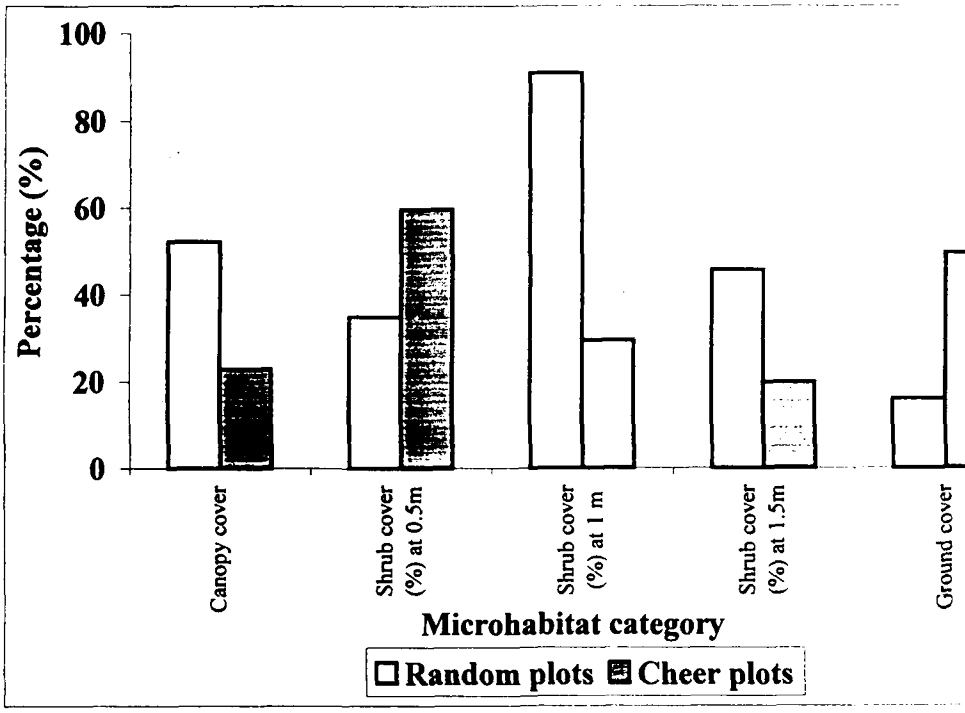


Figure 5.10 Microhabitat variables between random and cheer plots in first year.

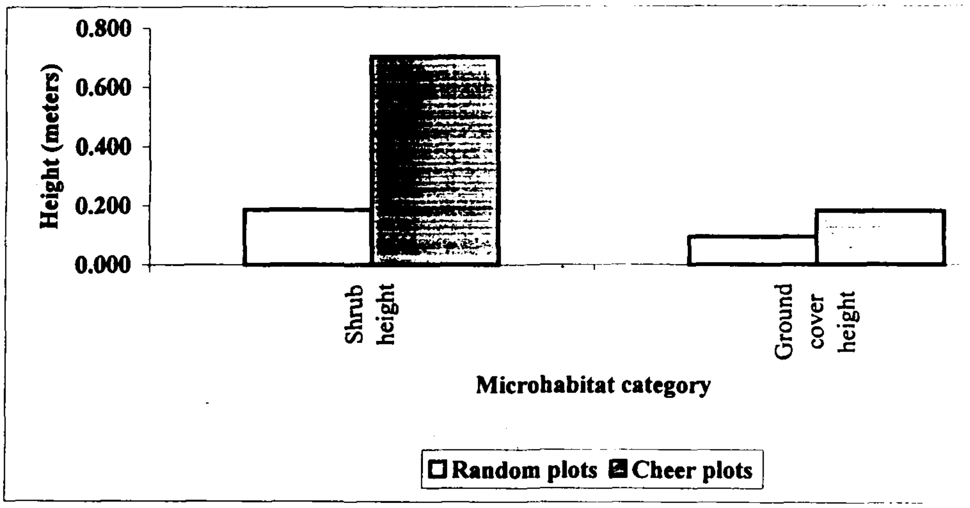


Figure 5.11 Microhabitat variables of random and cheer plots in first year.

Table 5.14 Microhabitat variables of random and cheer plots in post breeding season in first year.

Variables	Random Mean ± S.E.	Cheer Mean ± S.E.	F value	Sig.
Number of trees	6.247 (± 0.847)	0.923 (± 0.265)	3.595	0.060
Tree height	4.067 (± 0.447)	5.985 (± 1.802)	1.546	0.214
GBH	39.803 (± 4.333)	58.820 (± 17.950)	1.546	0.214
Number of sapling species	0.297 (± 0.043)	0.539 (± 0.144)	2.628	0.107
Number of sapling	0.895 (± 0.155)	1.154 (± 0.355)	0.245	0.621
Canopy cover	23.380 (± 2.855)	10.769 (± 2.878)	1.762	0.186
Total number of shrub species	1.880 (± 0.134)	3.462 (± 0.595)	11.053	0.001
Shrub cover at 0.5 meter	0.578 (± 0.038)	0.560 (± 0.089)	5.010	0.027
Shrub cover at 1 meter	0.330 (± 0.030)	0.560 (± 0.107)	4.798	0.030
Shrub cover at 1.5 meter	0.132 (± 0.026)	0.308 (± 0.133)	3.458	0.065
Shrub height	0.750 (± 0.051)	1.150 (± 0.121)	5.277	0.023
Shrub heterogeneity	0.088 (± 0.009)	0.154 (± 0.034)	4.241	0.041
Ground cover	50.106 (± 2.880)	79.231 (± 7.550)	8.837	0.003
Ground cover height	0.203 (± 0.018)	0.875 (± 0.148)	85.954	0.000
Ground cover heterogeneity	0.214 (± 0.026)	0.138 (± 0.036)	0.787	0.376

* One-way ANOVA, Degrees of freedom (df) = 1

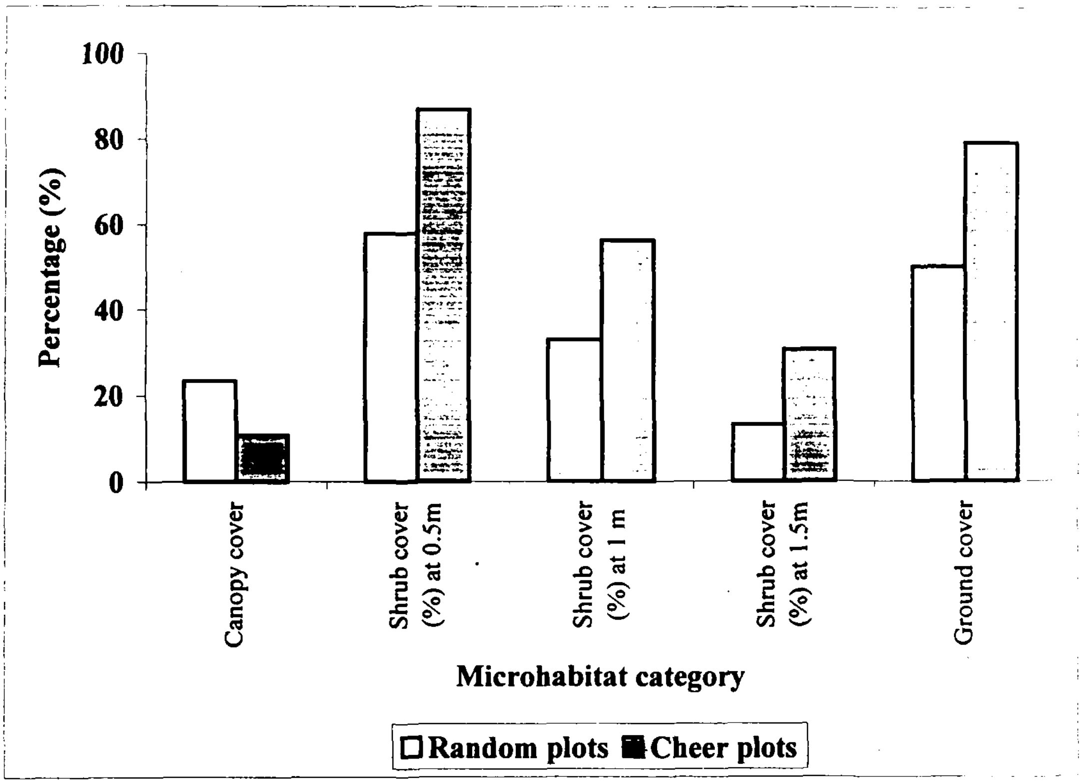


Figure 5.12 Microhabitat variables between random and cheer plots in first year in post-breeding season in first year

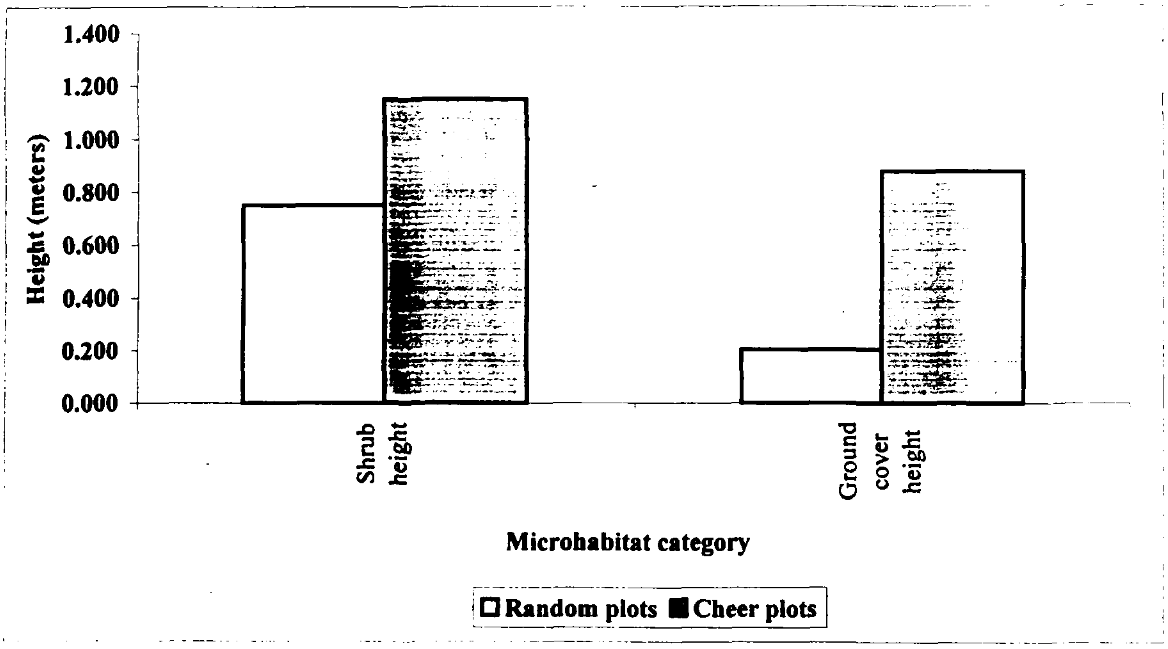


Figure 5.13 Microhabitat variables of random and cheer plots in first year in post breeding season

Table 5.15 Microhabitat variables of random and cheer plots in winter season in first year

Variables	Random Mean ± S.E.	Cheer Mean ± S.E.	F value	Sig.
Number of trees	8.434 (± 0.924)	4.313 (± 1.316)	1.735	0.189
Tree height	3.789 (± 0.350)	4.942 (± 0.923)	0.899	0.344
GBH	37.136 (± 3.414)	48.849 (± 9.571)	0.984	0.323
Number of sapling species	0.232 (± 0.037)	0.625 (± 0.155)	5.118	0.025
Number of sapling	1.062 (± 0.140)	2.063 (± 0.615)	3.941	0.049
Canopy cover	22.278 (± 2.268)	18.125 (± 4.584)	0.288	0.592
Total number of shrub species	1.989 (± 0109)	3.813 (± 0.319)	23.298	0.000
Shrub cover at 0.5 meter	0.633 (± 0.031)	0.969 (± 0.090)	10.484	0.001
Shrub cover at 1 meter	0.240 (± 0.028)	0.656 (± 0.090)	18.205	0.000
Shrub cover at 1.5 meter	0.263 (± 0.140)	0.324 (± 0.106)	0.017	0.897
Shrub height	0.708 (± 0.041)	1.318 (± 0.097)	19.095	0.000
Shrub heterogeneity	0.127 (± 0.012)	0.130 (± 0.031)	0.004	0.947
Ground cover	55.178 (± 2.262)	71.875 (± 3.78)	4.722	0.031
Ground cover height	0.197 (± 0.018)	0.758 (± 0.130)	60.139	0.000
Ground cover heterogeneity	0.184 (± 0.015)	0.142 (± 0.047)	0.702	0.403

* One-way ANOVA, Degrees of freedom (df) = 1

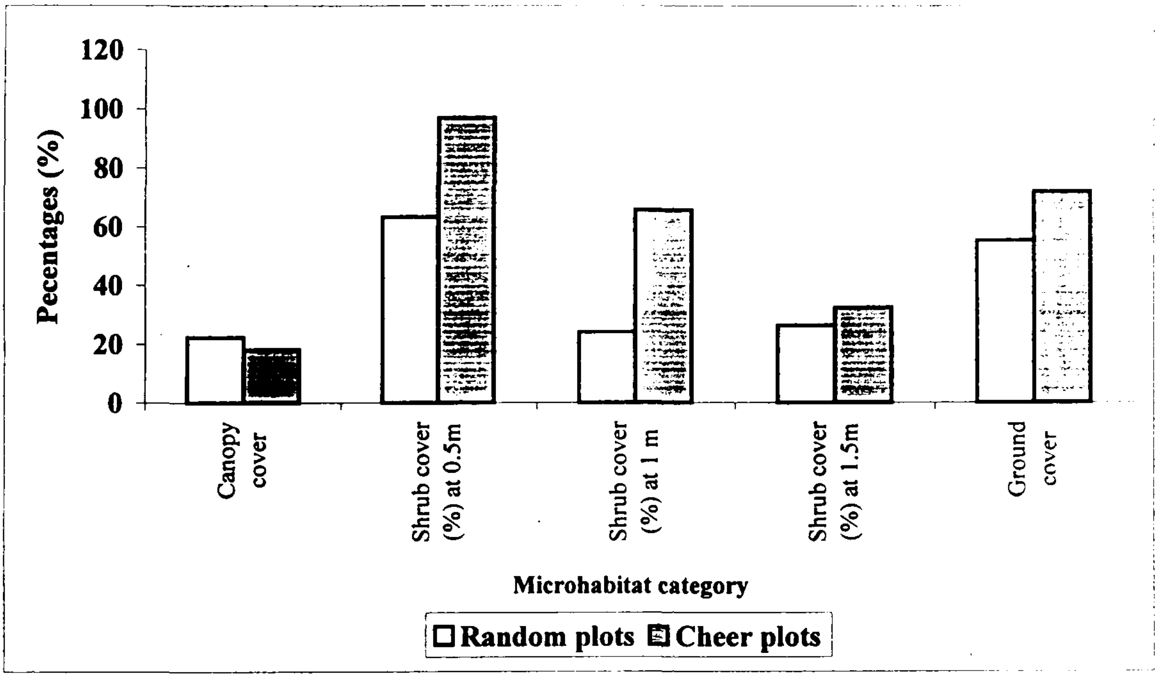


Figure 5.14 Micro habitat variables of random and cheer plots in first year in winter season

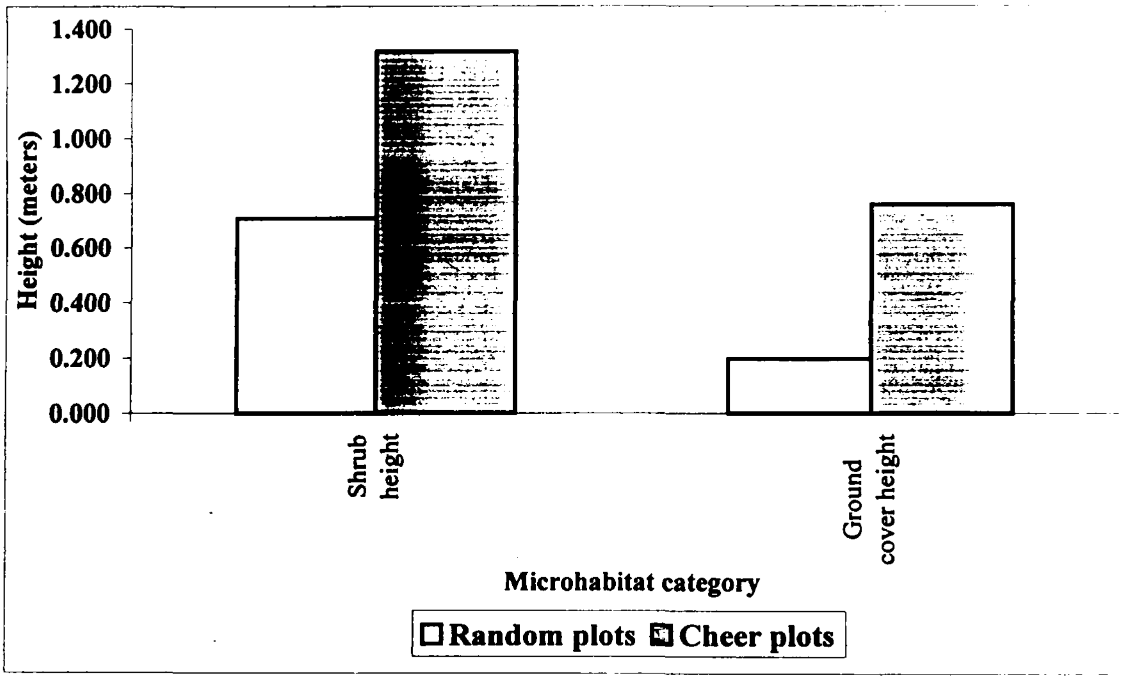


Figure 5.15 Micro habitat variables of random and cheer plots in first year in winter season

The microhabitat variables also varied significantly between cheer and random plots in the breeding season as well (Table 5.16). Mean height of trees, mean GBH of trees, number of shrub species, shrub cover at 0.5 meter, shrub cover at 1 meter, shrub height, shrub heterogeneity, ground cover and ground cover height were more in the cheer plots as compared to random plots while the total number of trees, ground cover heterogeneity, number of saplings species and the number of saplings were more in random plots as compared to cheer plots (Figure 5.16 & 5.17).

5.4.7.2.2 Second year:

In the second year, data on the microhabitat also varied significantly between cheer and random plots (Table 5.17). The microhabitat variables which were having higher values in cheer plots were mean GBH, number of shrubs species, shrub cover at 0.5 meter, shrub cover at 1 meter, shrub height, shrub heterogeneity, ground cover, ground cover height and number of sapling species and number of sapling as compared to random plots (Figure 5.17 & 5.18).

The microhabitat variables also varied significantly in the post-breeding season between cheer and the random plots (Table 5.18). The variables which were having higher values in random plots were total number of trees, mean canopy cover, shrub cover at 1.5 meter and ground cover heterogeneity while mean height of trees, mean girth at breast height, number of shrub species, mean shrub height, shrub cover at 0.5 meter, shrub cover at 1 meter, mean shrub height, shrub heterogeneity, ground cover, ground cover height, number of sapling species, and number of sapling were having high value then those of the random plots (Figure 5.20 & 5.21).

Table 5.16 Micro habitat variables of random and cheer plots in breeding season in first year

Variables	Random Mean ± S.E.	Cheer Mean ± S.E.	F value	Sig.
Number of trees	9.001(± 0.977)	2.500 (± 0.473)	10.629	0.001
Tree height	3.846 (± 0.357)	4.741 (± 0.694)	1.254	0.264
GBH	37.806 (± 3.564)	51.367 (± 6.897)	2.891	0.090
Number of sapling species	0.995 (± 0.129)	0.274 (± 0.127)	7.227	0.008
Number of sapling	23.167 (± 2.420)	11.818 (± 2.063)	5.138	0.024
Canopy cover	23.167 (± 2.420)	11.818 (± 2.063)	5.138	0.024
Total number of shrub species	1.889 (± 0.146)	3.364 (± 0.260)	20.922	0.000
Shrub cover at 0.5 meter	0.571 (± 0.035)	0.899 (± 0.028)	20.632	0.000
Shrub cover at 1 meter	0.319 (± 0.032)	0.352 (± 0.054)	0.231	0.631
Shrub cover at 1.5 meter	0.187 (± 0.028)	0.099 (± 0.041)	2.162	0.143
Shrub height	0.661 (± 0.050)	0.926 (± 0.065)	6.138	0.014
Shrub heterogeneity	0.076 (± 0.007)	0.172 (± 0.019)	29.802	0.000
Ground cover	43.111 (± 2.535)	66.136 (± 2.327)	19.150	0.000
Ground cover height	0.152 (± 0.012)	0.197 (± 0.017)	2.821	0.094
Ground cover heterogeneity	0.088 (± 0.008)	0.064 (± 0.008)	2.257	0.134

* One-way ANOVA, Degrees of freedom (df) = 1

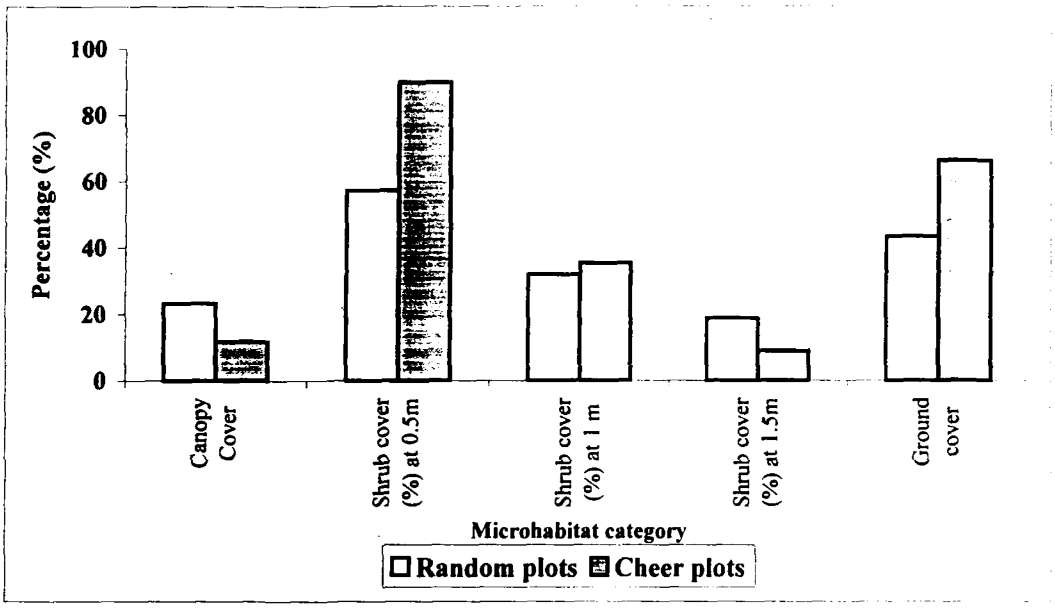


Figure 5.16 Micro habitat variables of random and cheer plots in first year in breeding season

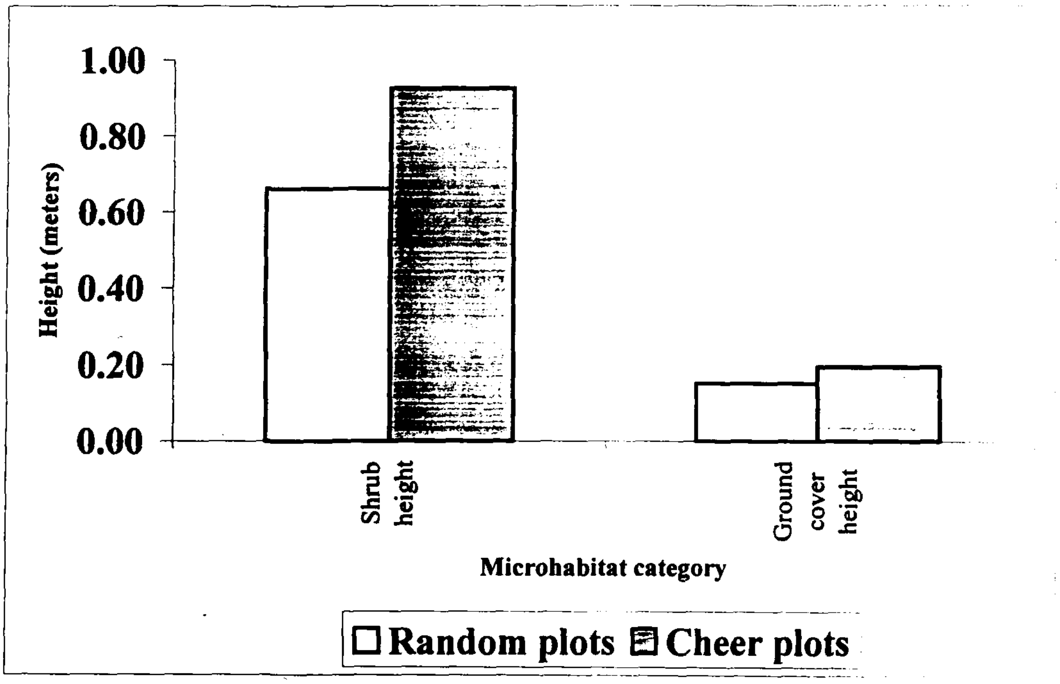


Figure 5.17 Micro habitat variables of random and cheer plots in first year in breeding season

Table 5.17 Over all micro habitat variables of random and cheer plots in second year

Variables	Random Mean ± S.E.	Cheer Mean ± S.E.	F value	Sig.
Number of trees	7.415 (± 0.490)	4.440 (± 0.475)	10.831	0.001
Tree height	3.741 (± 0.217)	5.131 (± 0.358)	10.132	0.002
GBH	37.873 (± 2.213)	51.704 (± 3.643)	9.649	0.002
Number of sapling species	0.247 (± 0.021)	0.301 (± 0.041)	1.478	0.225
Number of sapling	0.805 (± 0.078)	1.127 (± 0.185)	3.443	0.064
Canopy cover	23.042 (± 1.482)	16.267 (± 1.346)	6.037	0.014
Total number of shrub species	1.435 (± 0.060)	2.213 (± 0.116)	38.127	0.000
Shrub cover at 0.5 meter	0.599 (± 0.021)	0.789 (± 0.031)	19.645	0.000
Shrub cover at 1 meter	0.312 (± 0.019)	0.440 (± 0.034)	10.592	0.001
Shrub cover at 1.5 meter	0.175 (± 0.017)	0.069 (± 0.016)	11.358	0.001
Shrub height	0.744 (± 0.083)	0.786 (± 0.040)	0.078	0.780
Shrub heterogeneity	0.104 (± 0.006)	0.131 (± 0.009)	4.557	0.033
Ground cover	51.00 (± 1.522)	76.200 (± 1.261)	80.178	0.000
Ground cover height	0.250 (± 0.013)	0.528 (± 0.033)	91.263	0.000
Ground cover heterogeneity	0.120 (± 0.007)	0.089 (± 0.011)	232.710	0.000

* One-way ANOVA, Degrees of freedom (df) = 1

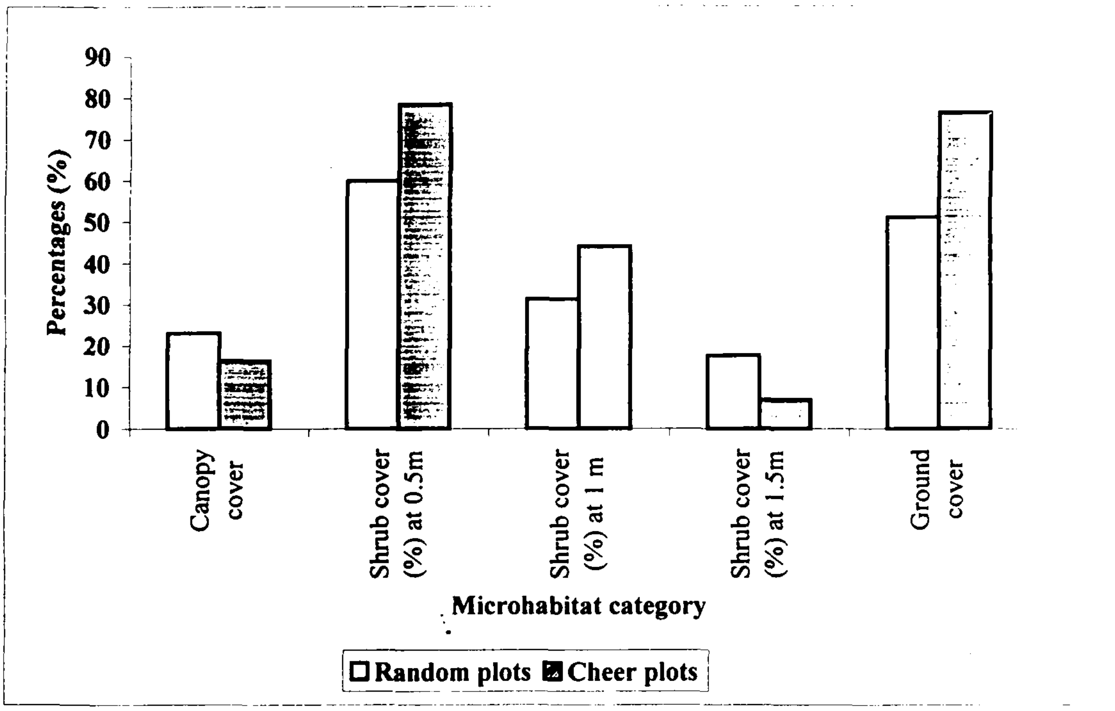


Figure 5.18 Overall microhabitat variables of random and cheer plots in second year

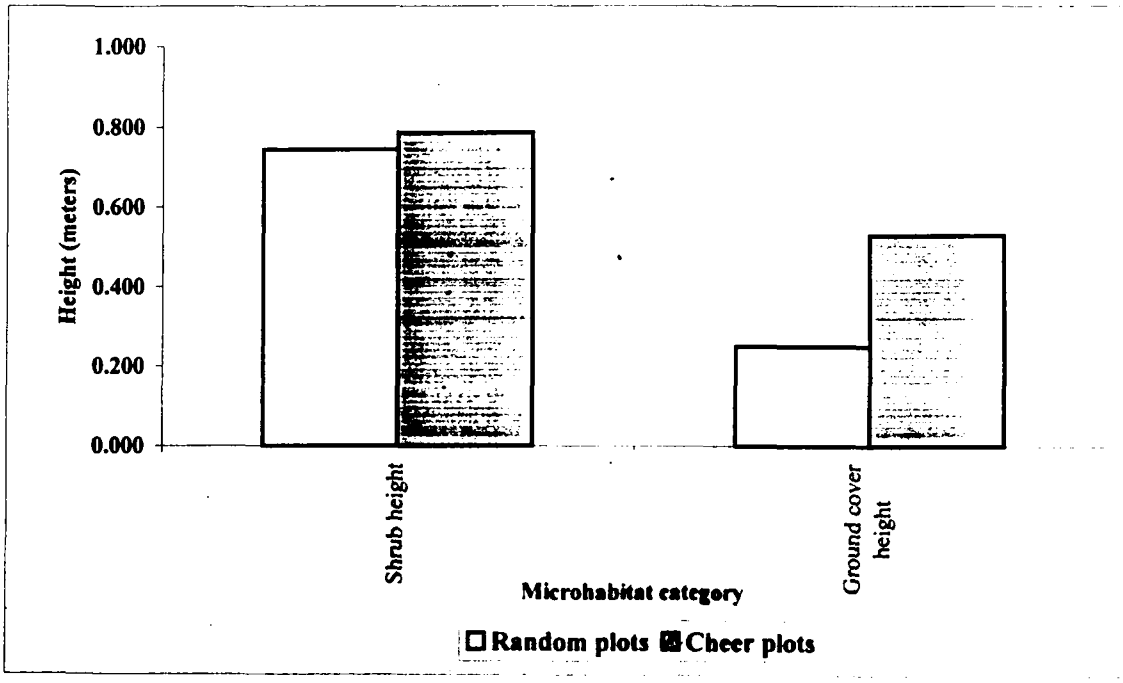


Figure 5.19 Overall microhabitat variables of random and cheer plots in second year

Table 5.18 Overall microhabitat variables of random and cheer plots in post breeding season in second year

Variables	Random Mean ± S.E.	Cheer Mean ± S.E.	F value	Sig.
Number of trees	8.567 (± 1.103)	2.324 (± 0.485)	8.901	0.003
Tree height	3.513 (± 0.409)	4.348 (± 0.714)	0.946	0.332
GBH	35.998 (± 4.211)	43.960 (± 7.252)	0.818	0.367
Number of sapling species	0.234 (± 0.041)	0.442 (± 0.096)	5.140	0.025
Number of sapling	0.709 (± 0.134)	1.559 (± 0.356)	7.338	0.008
Canopy cover	27.083 (± 3.386)	13.235 (± 2.452)	4.531	0.035
Total number of shrub species	1.175 (± 0.107)	1.853 (± 0.264)	7.661	0.006
Shrub cover at 0.5 meter	0.528 (± 0.043)	0.674 (± 0.070)	2.665	0.105
Shrub cover at 1 meter	0.198 (± 0.035)	0.265 (± 0.068)	0.813	0.369
Shrub cover at 1.5 meter	0.143 (± 0.032)	0.034 (± 0.030)	3.042	0.083
Shrub height	0.497 (± 0.052)	0.621 (± 0.081)	1.339	0.249
Shrub heterogeneity	0.095 (± 0.012)	0.114 (± 0.017)	0.650	0.421
Ground cover	46.917 (± 3.423)	80.294 (± 3.337)	24.944	0.000
Ground cover height	0.221 (± 0.025)	0.471 (± 0.037)	23.628	0.000
Ground cover heterogeneity	0.075 (± 0.009)	0.121 (± 0.036)	56.367	0.000

* One-way ANOVA, Degrees of freedom (df) = 1

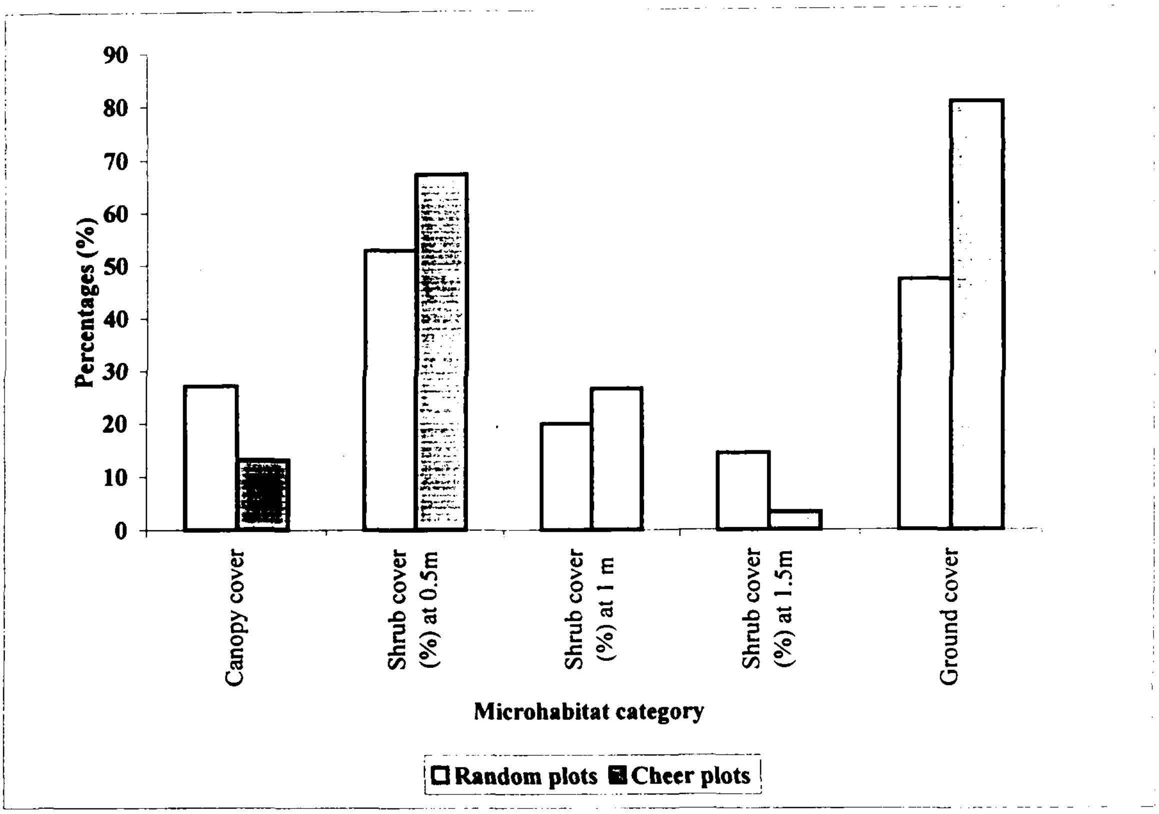


Figure 5.20 Microhabitat variables of random and cheer plots of post breeding season in second year

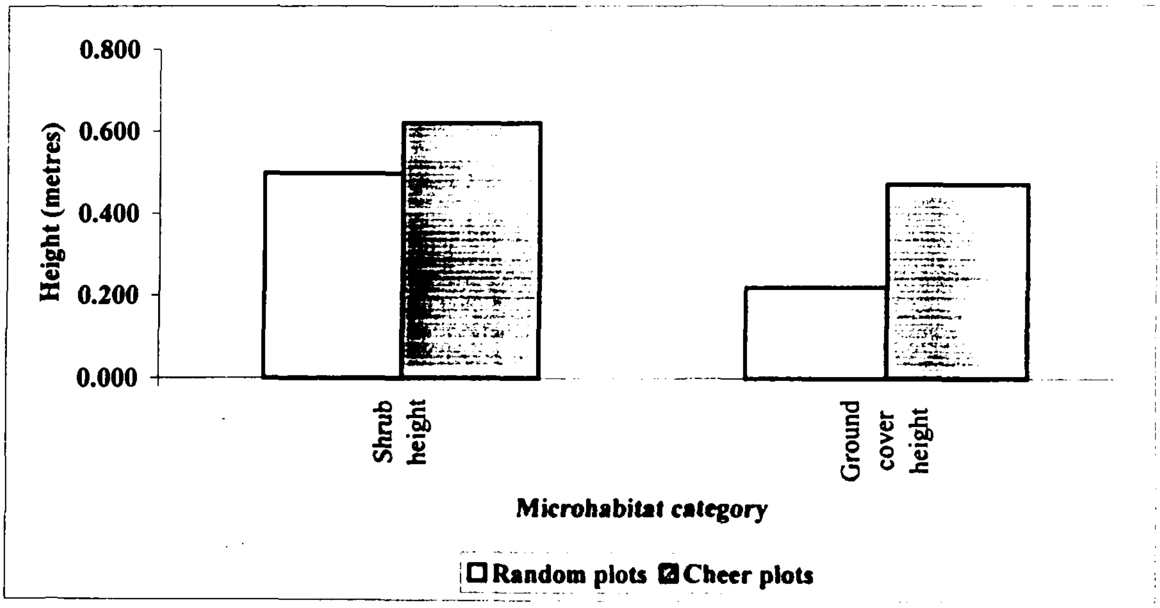


Figure 5.21 Microhabitat variables of random and cheer plots of post breeding in second year

In winter, the micro habitat variables also varied significantly between cheer and random plots (Table 5.19). The total number of trees, canopy cover, shrub cover at 1.5 meter, ground cover heterogeneity, number sapling species and number of sapling were more in random plots as compared to cheer plots while mean tree height, mean girth at breast height, number of shrub species, shrub cover at 0.5 meter, shrub cover at 1 meter, shrub height, shrub heterogeneity, ground cover, ground cover height, were more in cheer plots as compared to random plots (Figure 5.22 & 5.23).

In breeding season, the variables at the micro habitat level also varied significantly between the random and cheer plots (Table 5.20). The variables which were having higher values in random plots are total number of trees, canopy cover, shrub cover at 1.5 meter, shrub height, ground cover heterogeneity and number of sapling while in cheer plots mean tree height, mean girth at breast height, number of shrub species, shrub cover at 0.5 meter and shrub cover at 1 meter, shrub height, ground cover, ground cover height, number of sapling species and number of sapling were having more values then those of random plots (Figure 5.24 & 5.25).

Table 5.19 Micro habitat variables of random and cheer plots in winter season in second year

Variables	Random Mean ± S.E.	Cheer Mean ± S.E.	F value	Sig.
Number of trees	7.339 (± 0.811)	4.788 (± 0.928)	2.575	0.110
Tree height	4.093 (± 0.376)	5.278 (± 0.681)	2.252	0.135
GBH	41.594 (± 3.872)	54.120 (± 7.013)	2.373	0.125
Number of sapling species	0.301 (± 0.038)	0.193 (± 0.055)	1.998	0.159
Number of sapling	1.084 (± 0.150)	0.905 (± 0.333)	0.292	0.590
Canopy cover	21.389 (± 2.2007)	17.692 (± 2.755)	0.716	0.398
Total number of shrub species	1.317 (± 0.092)	2.192 (± 0.216)	17.831	0.000
Shrub cover at 0.5 meter	0.564 (± 0.035)	0.734 (± 0.059)	5.423	0.21
Shrub cover at 1 meter	0.322 (± 0.032)	0.515 (± 0.062)	7.993	0.005
Shrub cover at 1.5 meter	0.188 (± 0.028)	0.088 (± 0.029)	3.217	0.072
Shrub height	0.662 (± 0.050)	0.773 (± 0.077)	1.192	0.276
Shrub heterogeneity	0.092 (± 0.376)	0.098 (± 0.012)	0.149	0.700
Ground cover	48.389 (± 2.432)	76.731 (± 2.326)	36.364	0.000
Ground cover height	0.231 (± 0.021)	0.791 (± 0.073)	100.348	0.000
Ground cover heterogeneity	0.140 (± 0.038)	0.074 (± 0.008)	64.835	0.000

* One-way ANOVA, Degrees of freedom (df) = 1

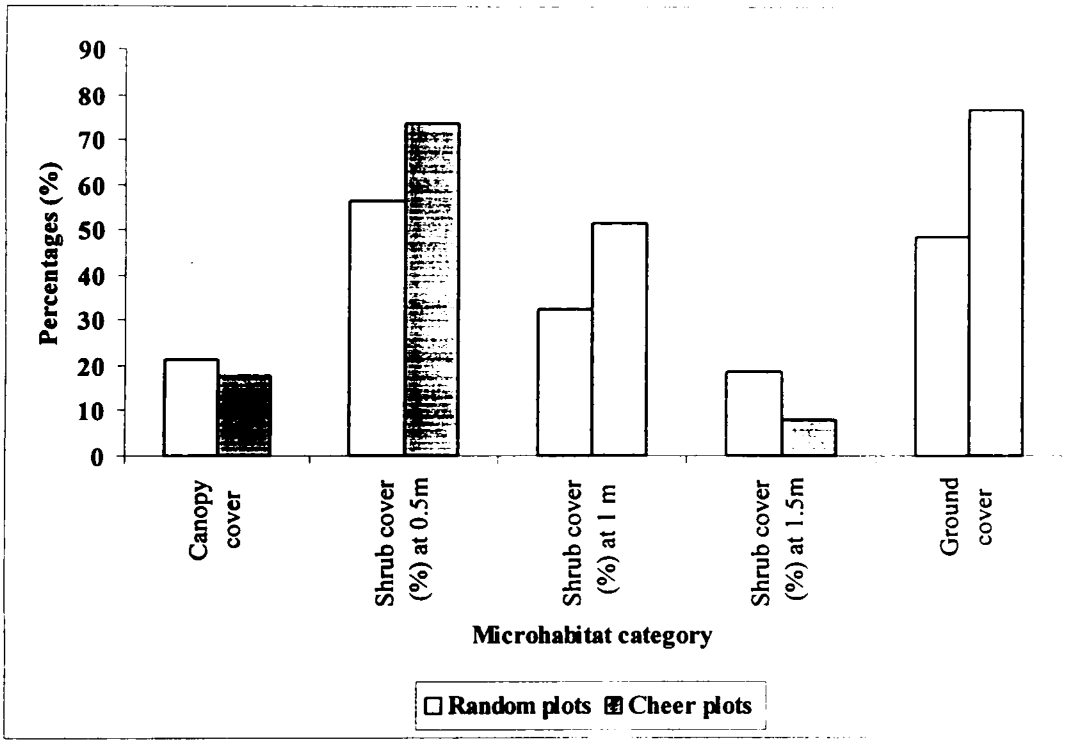


Figure 5.22 Microhabitat variables of random and cheer plots of winter season in second year

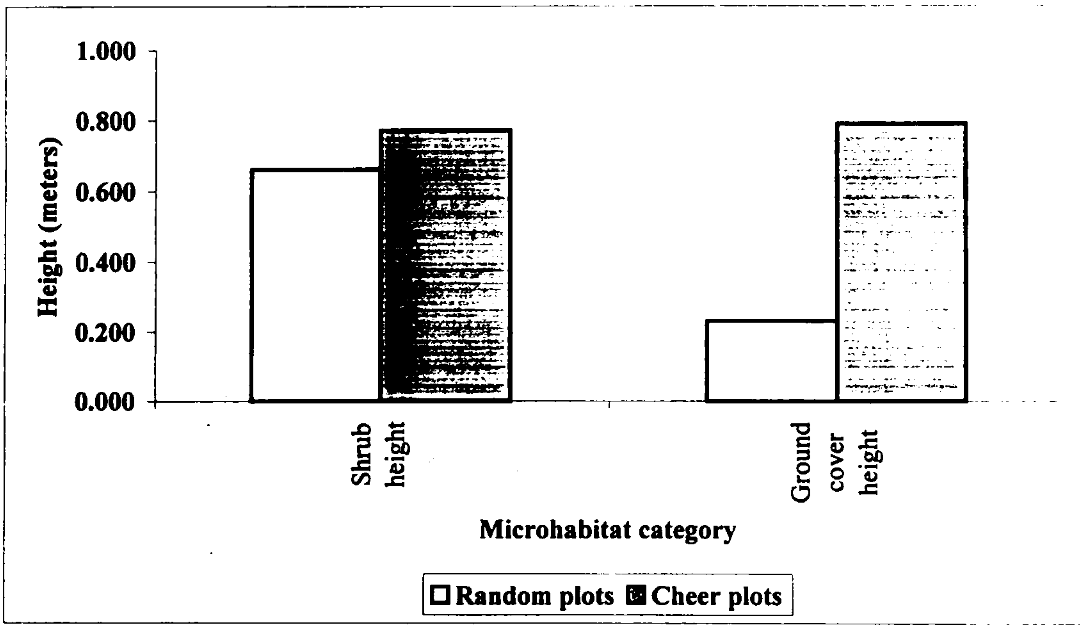


Figure 5.23 Microhabitat variables of random and cheer plots of winter season in second year

Table 5.20 Micro habitat variables of random and cheer plots in breeding season in second year

Variables	Random Mean ± S.E.	Cheer Mean ± S.E.	F value	Sig.
Number of trees	6.722 (± 0.713)	5.188 (± 0.757)	1.439	0.231
Tree height	3.542 (± 0.344)	5.426 (± 0.508)	8.360	0.004
GBH	35.402 (± 3.461)	53.855 (± 5.094)	7.930	0.005
Number of sapling species	0.201 (± 0.033)	0.313 (± 0.066)	2.752	0.098
Number of sapling	0.590 (± 0.111)	1.079 (± 0.281)	3.829	0.052
Canopy cover	22.000 (± 2.376)	16.719 (± 1.810)	1.633	0.202
Total number of shrub species	1.728 (± 0.108)	2.422 (± 0.151)	11.831	0.001
Shrub cover at 0.5 meter	0.680 (± 0.033)	0.822 (± 0.038)	11.589	0.001
Shrub cover at 1 meter	0.378 (± 0.032)	0.471 (± 0.046)	2.420	0.121
Shrub cover at 1.5 meter	0.184 (± 0.027)	0.072 (± 0.025)	5.300	0.022
Shrub height	0.911 (± 0.213)	0.885 (± 0.051)	0.088	0.767
Shrub heterogeneity	0.123 (± 0,013)	0.168 (± 0.016)	3.504	0.062
Ground cover	56.333 (± 2.274)	73.594 (± 1.380)	19.536	0.000
Ground cover height	0.288 (± 0.719)	0.345 (± 0.028)	2.441	0.119
Ground cover heterogeneity	0.130 (± 0.10)	0.084 (± 0.014)	138.030	0.000

* One-way ANOVA, Degrees of freedom (df) = 1

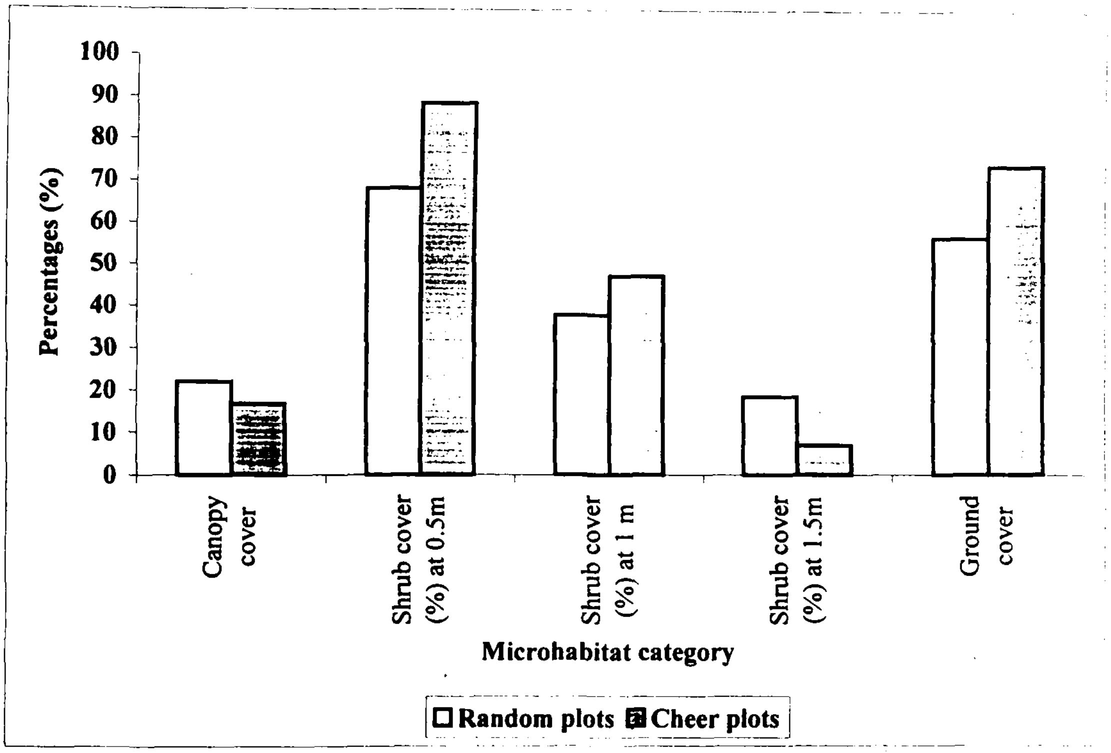


Figure 5.24 Microhabitat variables of random and cheer plots of breeding season in second year

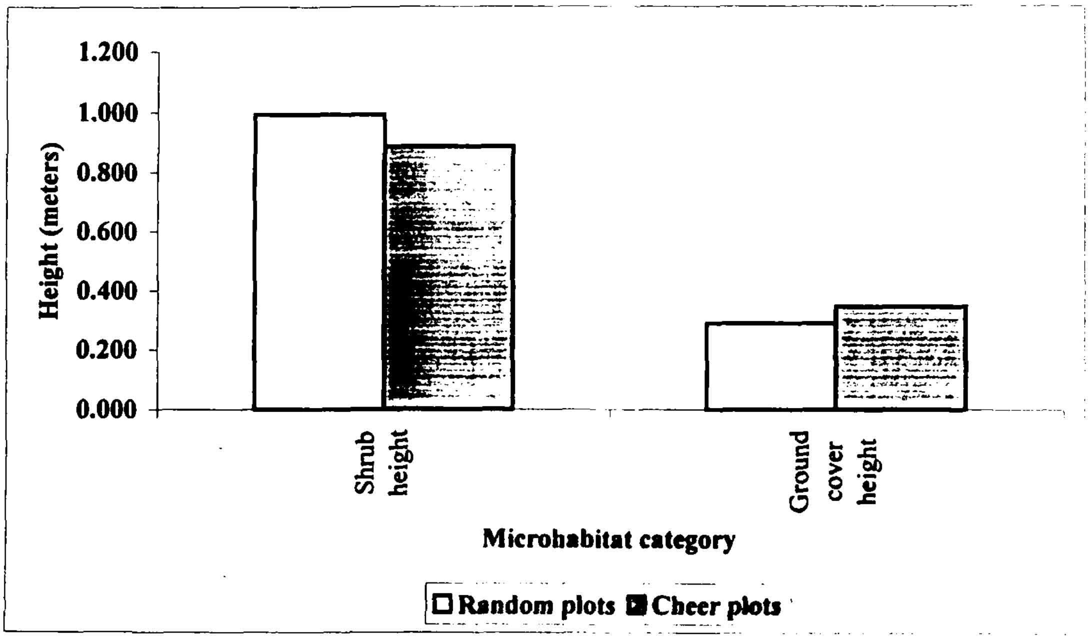


Figure 5.25 Microhabitat variables of random and random plots of breeding season in second year

5.4.7.3 Ordination of habitat variables

5.4.7.3.1 First Year:

Overall microhabitat of cheer plots versus random plots:

The four principal components (PC) were extracted, which explained 78.41% of the total variation. PC I explained 34.38% of the variance, while PC II explained 25.32% of the variance, third component explained 10.84 % of the variance and the fourth component explained 7.85 % of the variance. The component first had higher positive loading for tree density, GBH, numbers of tree species and canopy cover, while the number of shrub species, shrub cover at 0.5 meter and ground cover had higher negative loadings. This component explained that the forest was heading from open forest to mature forest. The second component had higher positive loading for shrub height, number of shrub species and shrub cover at 0.5 meter, while the canopy cover, ground cover height and ground cover was having higher negative loadings. The second component explained high shrub cover with low ground cover. The ground cover, ground cover height and ground cover heterogeneity where having high positive loadings while tree density, canopy cover and sapling density was having high negative loadings. This component explained high grass cover with low forest. The fourth component was having high positive loading on number of sapling, sapling density and ground cover while number of shrub species, shrub density at 0.5 meter and shrub height was having higher negative holding. This component explained high grass cover with low forest cover and low shrub cover (Table 5.21 & Figure 5.26).

Table 5.21 PCA scores of over all first year of random and cheer plots

	Factor Scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**0.906**	0.111	6.781E-03	-0.247
Tree density	**0.955**	0.124	-5.47E-02	-0.183
Sapling species	**0.719**	0.253	-1.22E-02	**0.587**
Sapling density	**0.743**	0.242	-3.84E-02	**0.561**
Canopy cover	**0.918**	8.098E-02	-9.70E-02	-0.150
Girth at Breast Height	**0.922**	0.110	1.740E-02	-0.240
Shrub species	-1.66E-02	**0.925**	0.104	-0.103
Shrub cover at 0.5 meter	-5.43E-02	**0.917**	0.105	-8.93E-02
Shrub cover at 1 meter	-0.419	**0.799**	-8.90E-02	9.176E-02
Shrub cover at 1.5 meter	-0.403	**0.606**	-0.276	0.138
Shrub height	-0.178	**0.964**	4.557E-02	-2.26E-02
Shrub heterogeneity	8.228E-02	0.489	0.288	-0.369
Ground cover	-8.19E-02	-0.144	**0.884**	-1.15E-02
Ground cover height	4.976E-02	9.70E-02	**0.817**	0.114
Ground cover heterogeneity	9.102E-02	-2.63E-02	0.348	0.289

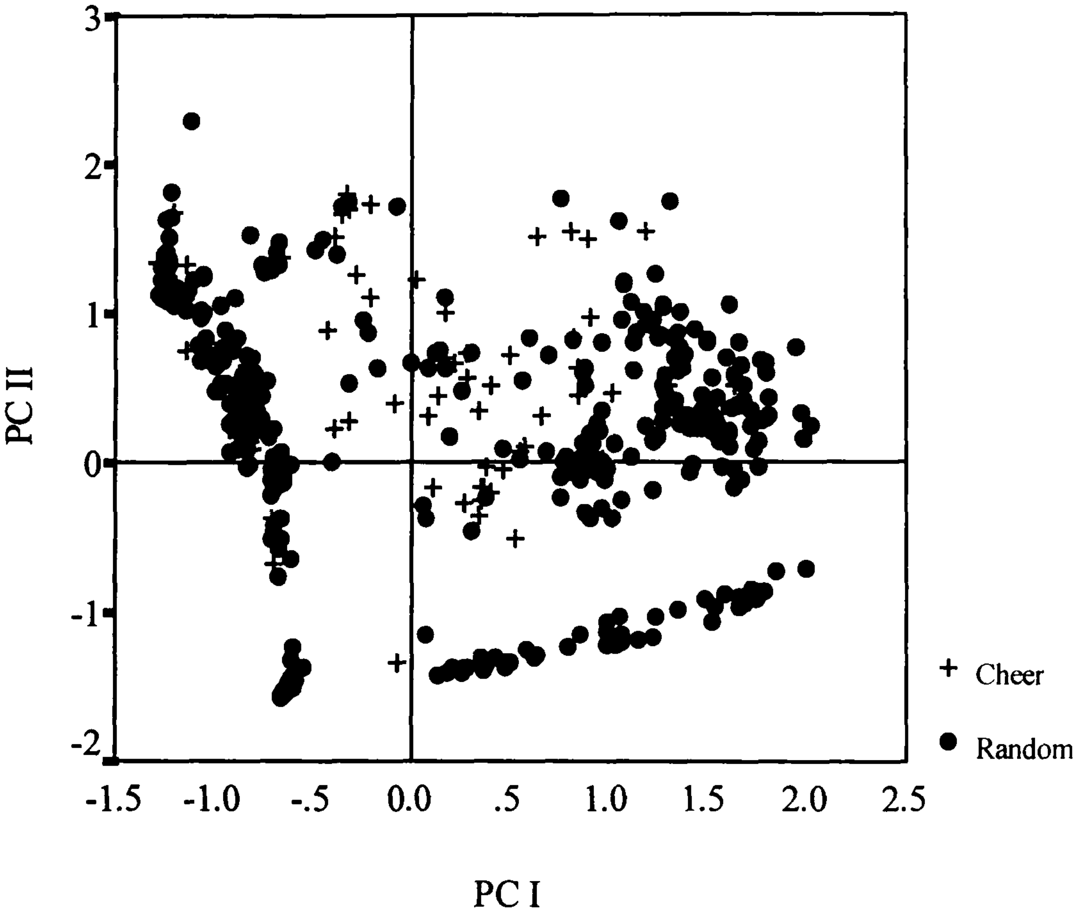


Figure 5.26 Principal Component scores of PC I and PC II in first year between random and cheer plots.

Post Breeding Season:

The first four components explained 81.16 % of the variation. The first component explained 32.32 % of the variation, second component explained 27.41 % of the variation, 12.37 % was explained by the third component and the fourth component explained 9.05 % of the variation. The first component was having high positive loading on shrub cover at 1 meter and 0.5 meter and shrub height, respectively, and ground cover heterogeneity, tree density and girth at breast height were having high negative loadings. This component explained high shrub cover with low forest and grass cover. The second component was having high positive loading on number of shrub species, shrub height and number of tree species respectively while ground cover, ground cover heterogeneity and shrub cover at 1.5 meter was having lower values, respectively. This component again explained medium shrub cover with low forest and grass cover. The third component was having higher loadings on ground cover, ground cover height and shrub heterogeneity while number of sapling species, sapling density and shrub cover at 1.5 meter were having higher negative loadings. This component explained good ground cover with low shrub density. The fourth component had higher positive loading on ground cover, ground cover height and number of sapling species, respectively while shrub cover at 0.5 meter, 1 meter and shrub height was having higher negative loadings. This component explained high ground cover with low shrub cover (Table 5.22 & Figure 5.27).

Table 5.22 PCA scores of random and cheer plots in post-breeding season in first year.

	Factor scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**-0.724**	**0.599**	0.158	-0.120
Tree density	**-0.764**	**0.586**	.006	-0.215
Sapling species	-0.270	**0.556**	**-0.597**	0.456
Sapling density	-0.317	0.572	-0.579	0.426
Canopy cover	**-0.730**	**0.551**	.002	-0.264
Girth at Breast Height	**-0.744**	**0.570**	0.169	-0.140
Shrub species	**0.563**	**0.741**	0.125	-0.165
Shrub cover at 0.5 meter	**0.700**	**0.631**	.008	-.003
Shrub cover at 1 meter	**0.803**	0.460	-0.218	**-.005**
Shrub cover at 1.5 meter	**0.619**	0.229	-0.430	-0.105
Shrub height	**0.687**	**0.687**	.0008	-.007
Shrub heterogeneity	0.388	0.430	0.402	-0.316
Ground cover	0.110	.009	**0.637**	0.585
Ground cover height	0.006	0.487	**0.519**	**0.559**
Ground cover heterogeneity	.007	0.179	-0.118	-0.121

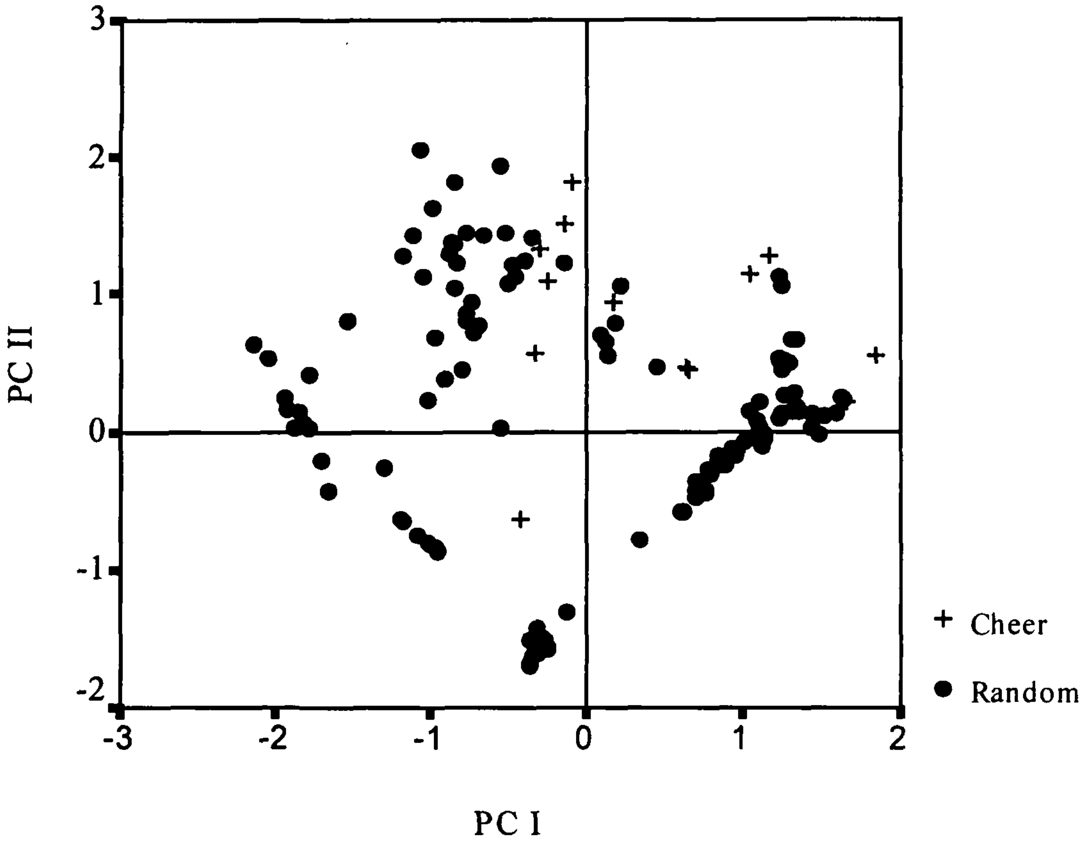


Figure 5.27 Principal Component scores of PC I and PC II of post-breeding season in first year between random and cheer plots.

Winter season:

The first four components explained 78.41 % of the variation. Component first explained 34.38 % of the variation, second component explained 25.32 % of the variation, while third component explained 10.84 % of the variation and the fourth component explained 7.85 % of the variation. The first component was having tree density, girth at breast height and canopy cover with high positive loadings while ground cover height, ground cover and shrub cover at 1.5 meter was having high negative loadings, respectively. This component explained high forest cover with very low grass cover. The shrub height, shrub cover at 0.5 meter and shrub cover at 1 meter was having higher positive loading while ground cover, number of sapling species and sapling density was having higher negative loading, respectively, in the second component. This component explained high shrub density between 0.5 meter and 1 meter with low grass cover. The third component was having higher loadings for ground cover, ground cover height and ground cover heterogeneity, respectively, while tree density, girth at breast height and number of tree species was having higher negative loading on this component respectively. This component explained good grass cover with low forest. The components which were having higher loading in the component fourth were ground cover height, shrub cover at 1.5 meter and 1 meter, respectively, while higher negative loadings components were shrub height, ground cover heterogeneity and shrub heterogeneity, respectively. This component explained medium shrub cover with medium ground cover (Table 5.23 & Figure 5.28).

Table 5.23 PCA scores of random and cheer plots in winter season in first year.

	Factor scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**0.897**	-0.154	-0.001	0.140
Tree density	**0.950**	-0.159	-0.006	0.008
Sapling species	**0.784**	-0.003	0.208	0.004
Sapling density	**0.791**	-0.004	0.157	0.004
Canopy cover	**0.915**	-0.192	-0.114	0.004
Girth at Breast Height	**0.927**	-0.154	-0.002	0.128
Shrub species	0.444	**0.777**	0.009	-0.181
Shrub cover at 0.5 meter	0.251	**0.872**	0.003	-0.160
Shrub cover at 1 meter	-0.125	**0.867**	-0.111	0.326
Shrub cover at 1.5 meter	-0.143	**0.719**	-0.241	0.365
Shrub height	0.213	**0.959**	0.0001	**-0.0003**
Shrub heterogeneity	0.311	0.343	0.149	-0.474
Ground cover	-0.269	-0.0006	**0.824**	0.115
Ground cover height	-.0002	.007	**0.805**	0.418
Ground cover heterogeneity	0.005	0.009	0.331	**-0.646**

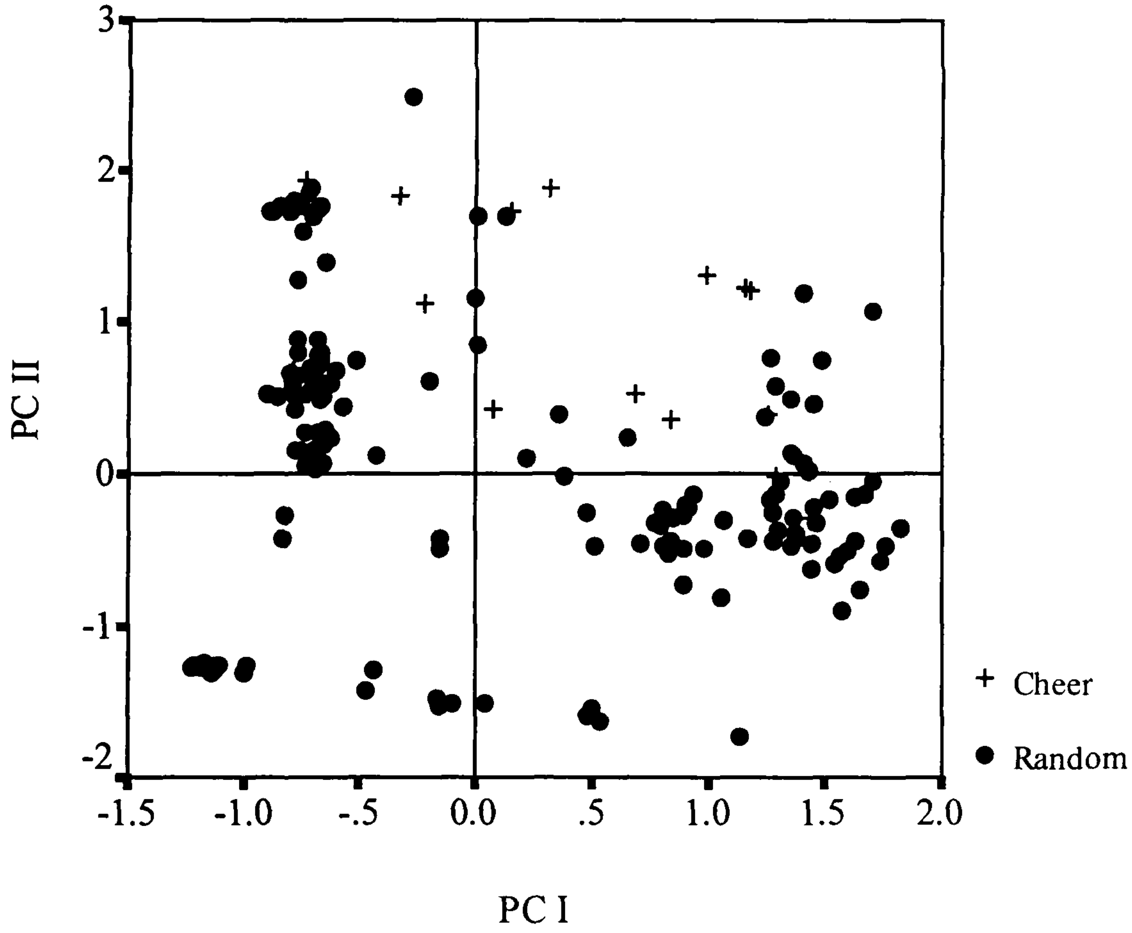


Figure 5.28 Principal Component scores of PC I and PC II of winter season in first year between random and cheer plots.

Breeding season:

The first four components explained 83.59 % of the variation. The first component accounted for 34.83% of the variation, second component explained 29.55 % of the variation while the third component explained 12.89 % of the variation and the fourth component explained 6.31 % of the variation. The first component was having higher positive loading on tree density, canopy cover and girth at breast height, respectively, while shrub density at 0.5 meter, 1 meter and 1.5 meter, respectively, was having higher negative loading. This component explained good forest cover with low shrub density at various levels. The second component was having high positive loading on Shrub cover at 0.5 meter, shrub height and number of shrub species, respectively, while high negative loading components were ground cover height, ground cover and ground cover heterogeneity, respectively. This component was medium shrub cover with good number of shrub species with low grass cover. The third component was having positive loading on ground cover, ground cover height and ground cover heterogeneity, respectively, while high negative loading were on sapling density, number of the sapling species and the tree density respectively. This component explained good grass cover with low forest cover. The components having high positive loadings in the forth component was ground cover heterogeneity, number of sapling species and sapling density while number of shrub species, ground cover and shrub cover at 0.5 meter was having high negative loadings, respectively. This component explained high sapling cover with low shrub cover (Table 5.24 & Figure 5.29).

Table 5.24 PCA scores of random and cheer plots in breeding season in first year.

	Factor scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**0.872**	0.224	0.001	-0.256
Tree density	**0.929**	0.259	-0.0004	-0.134
Sapling species	**0.769**	0.337	-0.004	0.431
Sapling density	**0.778**	0.330	-0.005	0.423
Canopy cover	**0.902**	0.211	-0.115	-6.21E-02
Girth at Breast Height	**0.888**	0.233	0.005	-0.252
Shrub species	-0.245	**0.885**	0.248	-8.23E-02
Shrub cover at 0.5 meter	-0.006	**0.909**	0.250	-6.92E-02
Shrub cover at 1 meter	**-0.549**	**0.723**	0.008	7.993E-02
Shrub cover at 1.5 meter	**-0.536**	**0.559**	-0.194	0.135
Shrub height	-0.354	**0.903**	0.155	-2.53E-02
Shrub heterogeneity	0.002	0.461	0.462	-0.329
Ground cover	0.007	-0.416	**0.823**	-6.95E-02
Ground cover height	.0007	**-0.589**	**0.644**	-2.45E-02
Ground cover heterogeneity	0.121	0.002	**0.643**	0.529

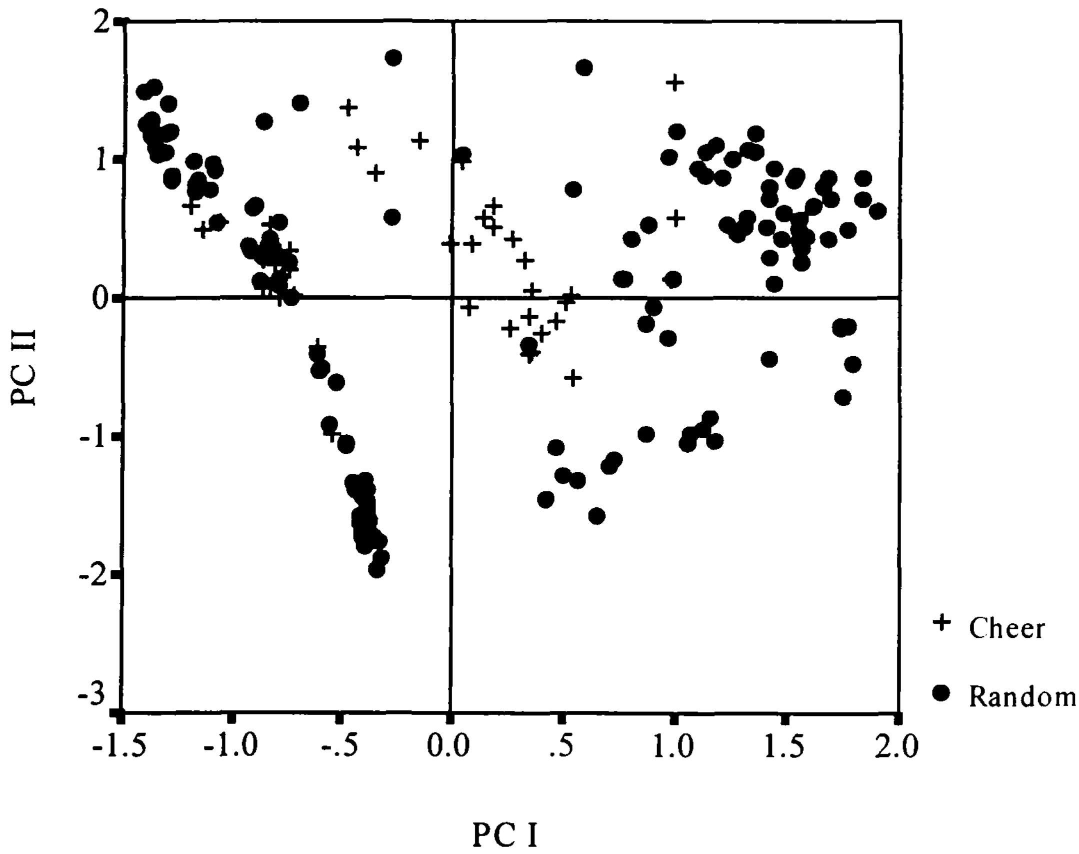


Figure 5.29 Principal Component scores of PC I and PC II of breeding season in first year between random and cheer plots.

5.4.7.3.2 Second Year:

Overall microhabitat of cheer plots versus random plots:

The first four components extracted and explained 78.69 % of the variation. The first component explained 32.39 % of the variation, the second component explained 25.62 % of the variation, while the third component explained 12.55% of the variation and the fourth component explained 8.11 % of the variation. The first component was having high positive loading on tree density, GBH and number of tree species while shrub heterogeneity, shrub cover at 1.5 meter and 1 meter was having high negative loadings. This component explained high forest cover with low shrub cover. The second component was having positive loading on number shrub species, shrub cover at 0.5 meter and the shrub height respectively while ground cover, ground cover heterogeneity and ground cover height were having high negative loadings. The component explained high shrub cover with low ground cover. The third component was having higher positive loadings on ground cover, ground cover height and shrub heterogeneity while GBH, shrub cover at 1 meter and shrub cover at 1.5 meter was having high negative loadings respectively. This component explained high ground cover with low shrub cover. The fourth component was having higher loadings on number of saplings, sapling density and ground cover heterogeneity respectively while higher negative loading were in ground cover, shrub heterogeneity and shrub cover at 1 meter respectively. This component explained forest regeneration with low ground cover and shrub cover (Table 5.25 & Figure 5.30).

Table 5.25 Overall PCA scores of random and cheer plots in second year.

	Factor scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**0.858**	0.329	-0.114	-0.245
Tree density	**0.874**	0.368	-0.141	-0.239
Sapling species	**0.597**	0.394	0.103	**0.653**
Sapling density	**0.623**	0.405	0.009	**0.626**
Canopy cover	**0.837**	0.293	-0.262	-0.224
Girth at Breast Height	**0.871**	0.337	-0.007	-0.275
Shrub species	-0.335	**0.860**	0.188	-0.006
Shrub cover at 0.5 meter	-0.298	**0.860**	0.209	-0.005
Shrub cover at 1 meter	**-0.557**	**0.673**	-0.006	-0.007
Shrub cover at 1.5 meter	**-0.581**	0.427	-0.346	0.002
Shrub height	-0.482	**0.811**	0.005	-0.005
Shrub heterogeneity	-0.003	**0.507**	0.344	-.008
Ground cover	0.183	-0.008	**0.892**	-0.008
Ground cover height	0.185	-0.212	**0.797**	-0.176
Ground cover heterogeneity	0.007	-0.001	0.003	0.309

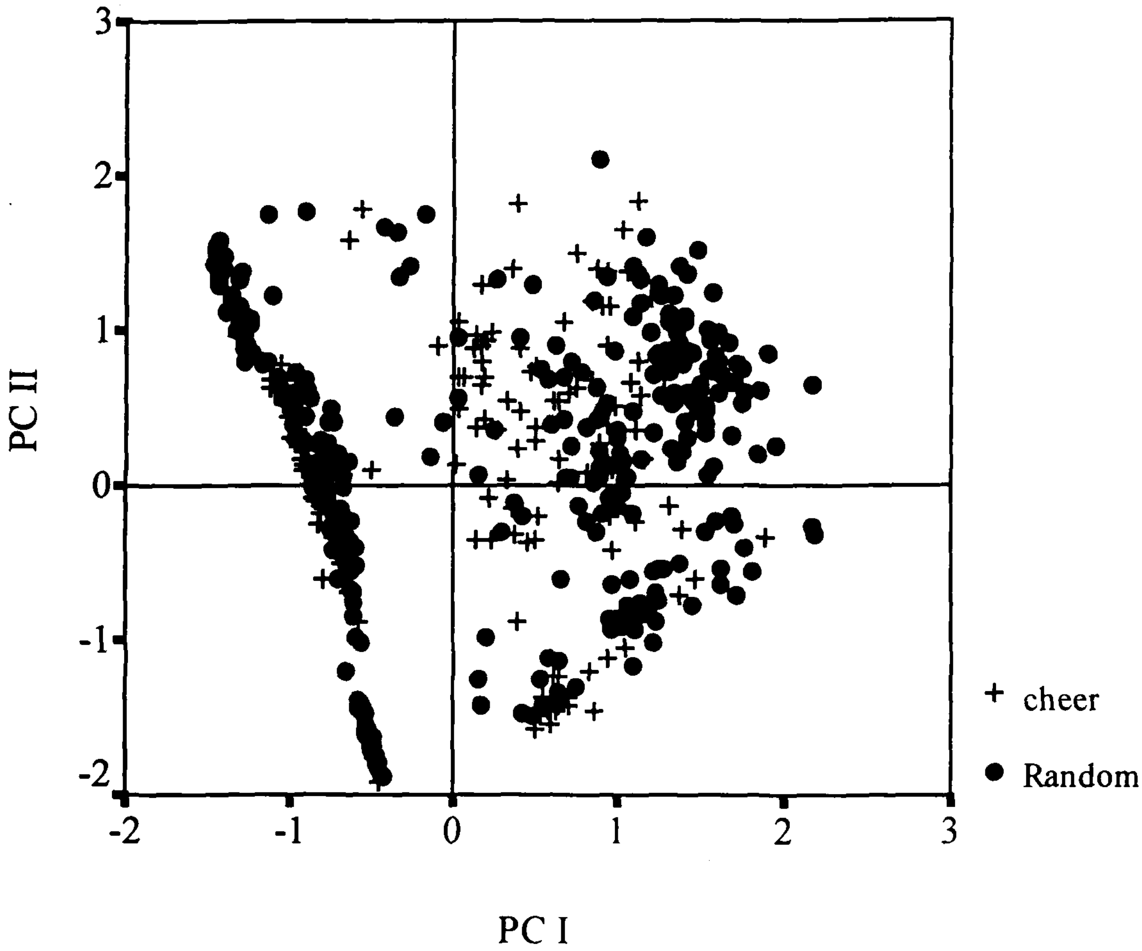


Figure 5.30 Overall Principal Component scores of PC I and PC II of second year between random and cheer plots.

Post breeding season:

The first four components explained 80.41 % of the variation. The first component explained 32.60 % of the variation, second component explained 26.35 % of the variation while the third component explained 13.56 % of the variation and the fourth component explained 7.89% of the variation. The first component was having higher positive loading on girth at breast height, tree density and number of tree species, respectively, while shrub cover at 0.5 meter, number of shrub species and ground cover heterogeneity was having higher negative loadings. This component explained high forest cover with low shrub cover. The second component was having higher positive loadings on number of shrub height, shrub species and shrub cover at 0.5 meter, respectively, while ground cover, ground cover heterogeneity and ground cover height was having higher negative loadings, respectively. The component explained good shrub cover with less ground cover. The third component was having higher positive loadings on ground cover, ground cover height shrub cover at 0.5 meter while the higher negative loading were on ground cover heterogeneity, canopy cover and shrub cover at 1.5 meter, respectively. This component explained high ground cover with low shrub and canopy cover. Ground cover heterogeneity, ground cover and canopy cover were having high positive loading in then fourth component while shrub cover at 1.5 meter, sapling density and number of saplings species was having higher negative loadings. This component explained high ground cover with low shrub and sapling cover (Table 5.26 & 5.31).

Table 5.26 PCA scores of random and cheer plots of post breeding season in second year

	Factor scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**0.910**	0.171	-0.136	0.104
Tree density	**0.921**	0.174	-0.224	0.189
Sapling species	0.723	0.207	0.261	-0.443
Sapling density	0.723	0.211	0.275	-0.451
Canopy cover	**0.851**	0.120	-0.324	0.249
Girth at Breast Height	**0.923**	0.167	-0.146	0.140
Shrub species	-0.006	**0.923**	0.192	**0.005**
Shrub cover at 0.5 meter	-0.007	**0.894**	0.225	0.105
Shrub cover at 1 meter	-0.420	**0.734**	-0.105	**0.0005**
Shrub cover at 1.5 meter	-0.502	**0.558**	-0.238	**-0.006**
Shrub height	-0.257	**0.945**	0.006	0.003
Shrub heterogeneity	0.208	**0.524**	0.183	0.003
Ground cover	0.195	-0.006	0.889	0.260
Ground cover height	0.004	-0.299	0.836	0.157
Ground cover heterogeneity	-0.005	-0.002	-0.002	**0.738**

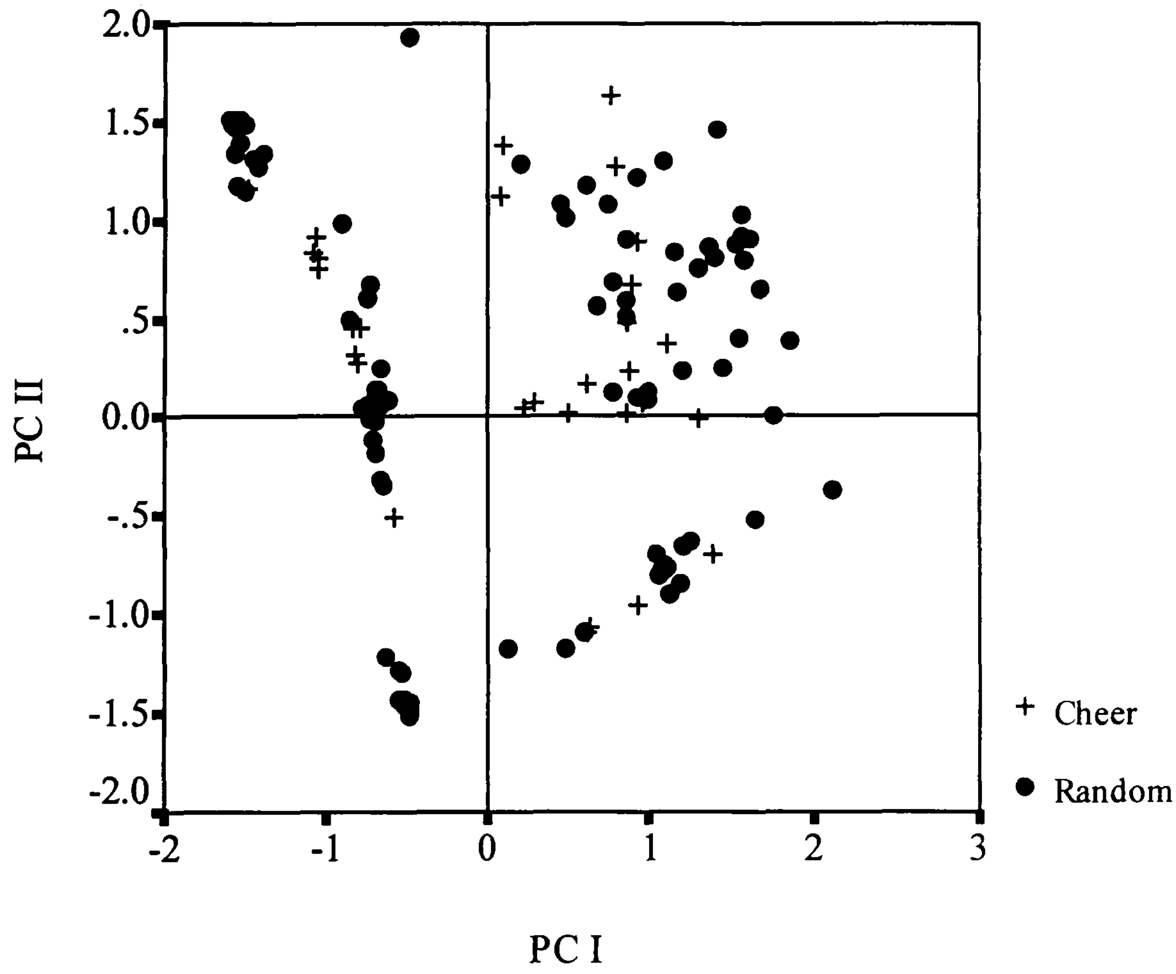


Figure 5.31 Principal Component scores of PC I and PC II of post breeding season of second year between cheer and random plots.

Winter season:

The first four components explained 82.67 % of the variation. The first component explained 35.76 % of the variation, second component explained 25.54 % of the variation, and third component explained 12.33 % of the variation while fourth component explained 9.023 % of the variation, respectively. The first component had high positive loading on girth at breast height, number of tree species and tree density respectively while shrub heterogeneity, shrub cover at 1 meter, and shrub height was having higher negative loadings. This component explained mature forest with low shrub cover. The second component was having high positive loadings on shrub cover at 0.5 meter , number of shrub species and shrub height while ground cover height, ground cover were having high negative loadings. This component explained medium shrub cover with very less ground cover. The third component was having high positive loadings on ground cover, ground cover height and shrub heterogeneity respectively while density of shrub at 1 meter, tree density and number of tree species was having high negative loadings respectively. This component explained high ground cover with fewer shrubs and forest cover. The fourth component was high positive loadings on ground cover heterogeneity, number of sapling species and sapling density while shrub height, number of shrub species and girth at breast height were having high negative loadings. This component explained good ground cover low shrub cover and low forest cover (Table 5.31 & Figure 5.32).

Table 5.27 PCA scores of random and cheer plots of winter season in second year

	Factor scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**0.828**	0.398	-0.002	-0.275
Tree density	**0.825**	0.470	-0.002	-0.241
Sapling species	**0.564**	0.518	0.004	0.447
Sapling density	**0.590**	0.528	0.002	0.420
Canopy cover	**0.826**	0.426	-0.168	-0.232
Girth at Breast Height	**0.839**	0.392	0.005	-0.281
Shrub species	**-0.548**	**0.759**	0.223	-0.002
Shrub cover at 0.5 meter	-0.485	**0.785**	0.242	0.003
Shrub cover at 1 meter	**-0.735**	**0.519**	**-0.005**	-0.158
Shrub cover at 1.5 meter	**-0.637**	0.353	-0.339	-0.176
Shrub height	**-0.659**	**0.716**	0.006	**-0.006**
Shrub heterogeneity	-0.009	**0.565**	0.384	0.193
Ground cover	0.133	-0.274	**0.853**	0.008
Ground cover height	0.117	-0.278	**0.831**	-0.205
Ground cover heterogeneity	0.149	0.002	-0.143	**0.749**

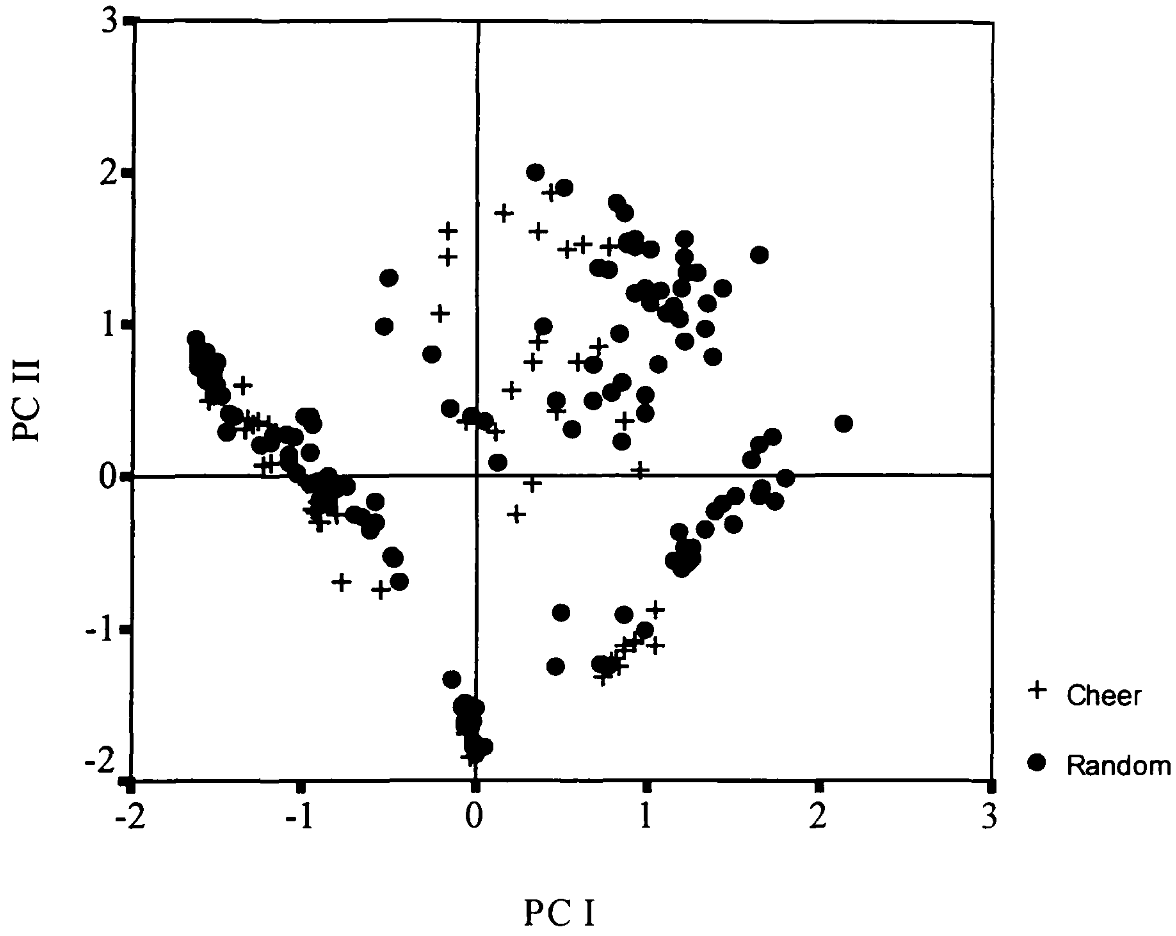


Figure 5.32 Principal Component scores of PC I and PC II in winter season in second year between random and cheer plots.

Breeding season:

The first four principal components extracted, explained 77.90 % of the variation. The first component explained 30.52 % of the variation, second component explained 25.41 % of the variation while component explained 12.42 % of the variation and fourth component explained 9.53 % of the variation. The first component was having density of trees, girth at breast height and number of tree species with higher positive loadings while number of shrub species, shrub cover at 0.5 meter and shrub cover at 1.5 meter was having higher negative loadings. This component explained good forest cover with low shrub cover. The second component was having number of shrub species, shrub cover at 0.5 meter and shrub height with high positive loadings while ground cover heterogeneity, ground cover and ground cover height were having high negative loadings in this component. The second component explained good shrub cover with low ground cover. The third component was having high loading on ground cover, ground cover height and shrub heterogeneity while shrub cover at 1.5 meter, canopy cover and tree density was having high negative loadings. This component explained high ground cover with less shrub cover and forest cover. The fourth component was having high positive loadings on canopy cover, GBH and tree density, respectively, while ground cover height, shrub cover at 1 meter and 1.5 meter was having higher negative loadings. This component explained high forest cover with low shrub and ground cover (Table 5.28 & Figure 5.33).

Table 5.28 PCA scores of random and cheer plots in breeding season in second year

	Factor scores			
Variables	**PC I**	**PC II**	**PC III**	**PC IV**
Tree species	**0.897**	0.154	-0.210	0.168
Tree density	**0.926**	0.108	-0.207	0.206
Sapling species	**0.596**	0.322	0.106	**-0.683**
Sapling density	**0.596**	0.322	0.106	**-0.683**
Canopy cover	**0.867**	0.009	-0.302	0.235
Girth at Breast Height	**0.911**	0.180	-0.186	0.225
Shrub species	-0.008	**0.894**	0.182	0.120
Shrub cover at 0.5 meter	-0.004	**0.891**	0.197	0.183
Shrub cover at 1 meter	-0.293	**0.822**	-0.109	-0.006
Shrub cover at 1.5 meter	-0.476	**0.540**	-0.385	-0.199
Shrub height	-0.261	**0.846**	0.0006	0.008
Shrub heterogeneity	0.0008	0.412	0.467	0.328
Ground cover	0.299	-0.006	**0.836**	0.0004
Ground cover height	0.377	-0.230	**0.661**	**-0.009**
Ground cover heterogeneity	0.003	-0.007	0.196	0.320

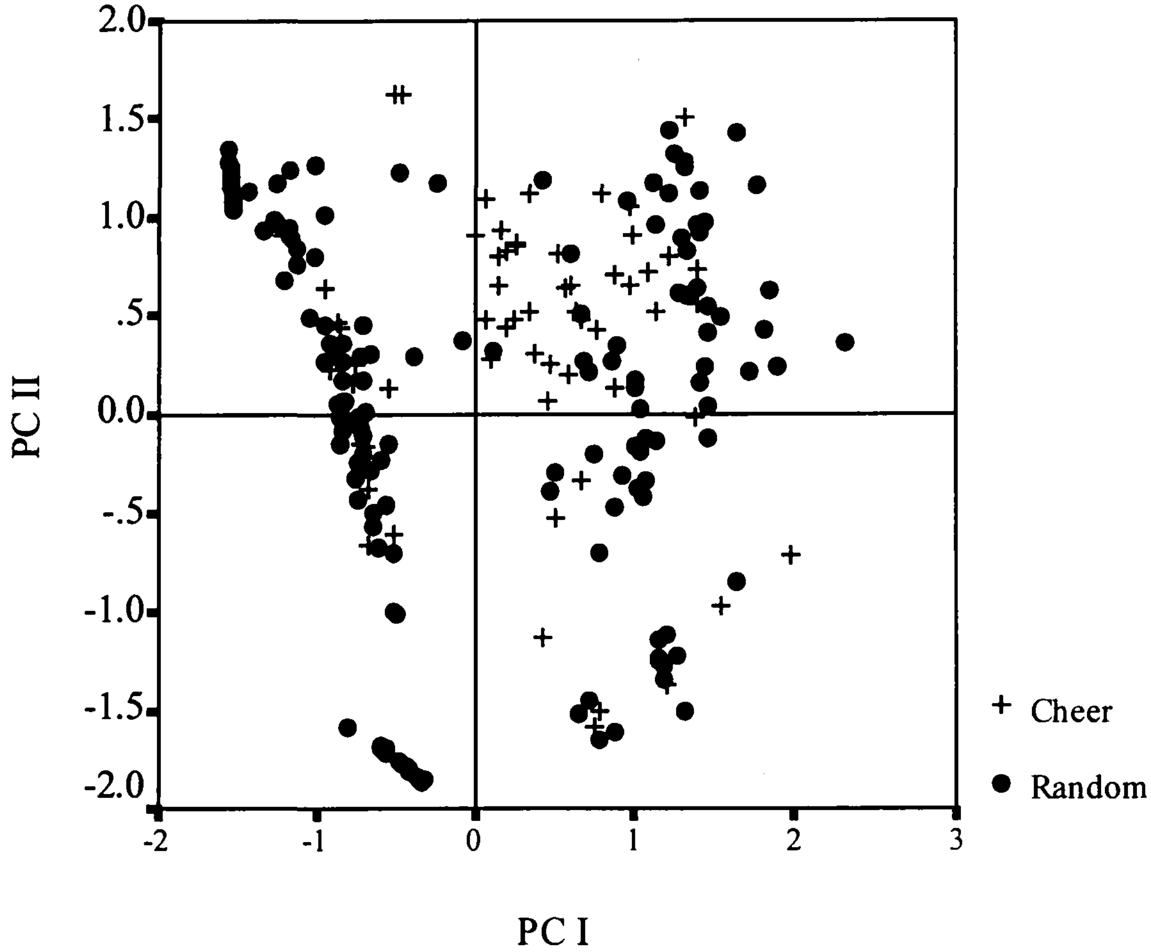


Figure 5.33 Principal Component scores of PC I and PC II in breeding season of second year between random and cheer plots.

5.5 Discussion:

The domain of selection for any habitat feature depends upon adaptations of the species under study and probability distributions of available habitat features in a landscape (Kopp *et al.* 1998). Majority of the pheasants favour dense woody or shrub vegetation (Fuller and Garson 2000) and only a handful of species inhabits more open habitats such as agricultural field (Indian peafowl), grassy slopes (cheer pheasant) and alpine meadow (Chinese monal).

The choice of a habitat is a key aspect to the ecology of birds especially pheasants. Many components play an important role in the choice of habitat in a bird (Cody 1985). Disproportional use of habitat is an indication whether a habitat is used more then available (preferred) or used less (avoided). This disproportional use of the habitat type was observed in the study. The availability/utilization analysis of overall cheer habitat data revealed that cheer used dense pine habitat in proportion to its availability. Whereas open pine, scrub and grass were used more than expected and oak, cultivation and degraded habitats were used less than expected. In winter, cheer used scrub and grass in proportion to its availability while open and dense pine habitats were used more than expected. During breeding season, dense pine was used in proportion to its availability while open pine, scrub and grass were used more than expected. In post-breeding season, open pine was used in proportion to its availability and scrub and grass were used more than expected. This shows that Cheer is much more a specialist species rather then a generalist species. There was change in habitat preference in different seasons, this can be attributed to the ecological response to factors and inter-intra specific competition for resources, the birds chose specific habitat characteristics or avoid each other temporally or both (Cody 1985). The Cheer preferred the open areas as compared to the closed forest. Habitat choice, however, also reflects other constraints. Open forests with low understory cover facilitate cheer taking flight, if suddenly required.

In this study, cheer used south and south-west facing slopes more than other aspects. In the temperate region, south facing slopes are vastly dry with relatively much less tree cover (Mani 1974), and north facing slopes are primarily dominated by conifer elements (Singh and Rawat 1999). Wherever the south facing slopes support good forest cover, the pheasants and other wildlife diversity is found to be rich (Dhar 1997). These areas also support high organic matter and less soil moisture (Singh and Rawat 1999), making the ground suitable for these ground-dwelling birds. Conifer elements within mixed forests, however, provide valuable roosting sites. But at the same time, as recorded by Islam and Crawford (1987) that structural component seems to determine the habitat condition for the species than purely the vegetation types. Utility of south and east facing aspects and gentle slopes is common in these species (Johnsgard 1986, Kumar 1997). Because, the south and east facing slopes support rich understorey (Singh 1999) and are comparatively warmer, the pheasants tend to use these slopes for breeding and roosting.

At the macrohabitat level, there was more grass and scrub in cheer habitat plots as compared to random plots which had more forest, terracing and bareground. There were significant differences between macrohabitat variables in cheer and random plots. During the two years of study, there was more of grass, scrub and slope in cheer habitat plots as compared to random plots in winter, breeding as well as post-breeding seasons.

Microhabitat analysis further highlighted habitat structure at both vertical and horizontal axes. Several authors (Lack 1933, 1940, Svardson 1949, Hilden 1965) have theorised that birds select habitats on the basis of 'sign stimuli" that convey information about the ultimate factors like food production and nest site availability. (Root 1967) documented cases in which given bird species appear to be directly associated with ultimate factors. Other studies have described the structural and functional components of vegetation usually involving some form of symbolism denoting items considered important to the avifauna present (Weins 1969). There were significant differences between microhabitat variables of cheer and random plots during winter, breeding and post-breeding seasons. Shrub cover at 0.5, 1.0 and 1.5 meters, shrub heterogeneity, ground cover and ground cover height in habitat plots for cheer was greater as compared to these variables at random plots. In Cabot's tragopan, previous studies have shown that the distance to the nearest water source, the distance to the nearest mountain ridge, the percentage cover at 0-1 meter above ground, the amount of trees, and topographical factors were the most important factors affecting whether the birds used the habitat (Zheng 1987, Young *et al.* 1991, Qian and Zheng 1993, Ding and Zheng 1997).

Habitat and community studies are multi dimensional in nature and are desirable to use multivariate statistical procedures to identify variables that may be useful in assessing habitat (Rextad *et al.* 1988). Thus for analysis of the cheer habitat variables, Principal Component Analysis (PCA) was used. PCA is a valuable tool evaluating multivariate habitat relations (Corner and Adkisson 1977). By this method we can identify the variables, which accounted for maximum variation in a data set and produces a smaller number of uncorrelated variables that account for maximum variation in a data set and produces a smaller number of uncorrelated variables that are the linear function of original variables (Bhattacharyya 1981, Seber 1984, Lehner 1979). Mac Authur and Mac Authur (1961) developed a technique to describe the layering of vegetation and found that by computing a foliage height diversity based upon the distribution of vegetation layers a one could predict the bird diversity of a given community. Sturman (1968) found that the canopy volume and upper story vegetation were significantly correlated with chikadaee abundance. Ordination of microhabitat variables using Principal Component Analysis brought about the separation between cheer and random habitat plots. The first principal component highlighted forested habitats, second principal component highlighted scrub and third principal component highlighted ground cover. Overall, cheer plots were in areas of high scrub and ground cover, and low forest cover. However, there were variations between the winter, breeding and post-breeding periods. During winter, cheer utilized more forest and scrub cover as compared to grass. In the breeding season, cheer used areas with low forest cover, medium to high shrub cover and high grass cover. In the post-breeding season, cheer used areas with low to medium forest cover, medium shrub and grass cover.

Khaling (1998) reported that breeding Satyr tragopans occurred in oak forests, preferring the forest edges with the shrub and ground cover forming important components of its habitat. Temminck's tragopan was also observed to occur in forest edges which were rich in grasses and bushes in spring. During their studies on Temminck's tragopan, Shi Hai Tao *et al.* (1996) reported that the species showed preference for areas of good cover and abundant bushes during the summer season. Tall dense vegetation may provide visual scent and physical barriers predators and nests of ground nesting birds (Bowman and Harris 1980, Redmond *et al.* 1982, Sugden and Beyersbergen 1986, Crabtree *et al.* 1989). The study of Delong *et al.* (1995) suggested that greater amount of tall grass cover and medium shrub height was collectively associated with lower probability of nest predation. Wallstead and Pyrah (1974) and Gregg *et al.* (1994) demonstrated that the greater amount of shrub cover at nest sites was associated with non-predated Sage grouse nests. These studies suggest that cover and height of the shrubs in a relatively small area (i.e. nest site) influences fate of the nest. Snyder (1984) observed that the number of early spring nests of Ring-necked pheasant placed at different nesting covers was directly related to height-density quality of vegetation. Pheasant breeding density was also related to the availability of woodland edges with high levels of shrub cover and arable land (Robertson *et al.* 1993a). Therefore, cover provided by shrub and ground level vegetation is probably an important factor influencing the breeding in ground nesting birds like Cheer pheasant.

Other aspects that affect habitat selection in birds are food, foraging, courtship and communication. Cheer used open area in grasslands and open pine forests which provided food for this species which feeds on ground as well as areas for advertisement and communication. In the post-breeding and winter seasons, cheer used areas with more forest and shrub. Rearing of broods requires areas with good cover for protection. Studies (Meyers *et al.* 1988) have revealed that the survival of Ring-necked pheasants depended partly on the habitats they used because survival of broods was related to availability of thicker cover types and in some cover types, survival was a function of the age of the brood.

Chapter 6

Social Organization

6.1 Introduction

Social organization refers to the behavioural responses of the individuals to the members of their own species. These relations are due to series of behavioural interaction, which take place during different phases of their annual cycle, or due to change in the environment (Lehner 1979). The behavioral traits in an animal come from parents or neighbours through learning; the way it behaves (i.e. feeds, avoid predators, communicates, cares for young) is crucial for its own survival and its chances of contributing its genes to the future generations (Kerbs and Davis 1978).

Social organization is a complex behavioural characteristic that determines the mode of dispersion of a population and the inter-individual encounters within it. Most of the studies of the birds appeared to have loused on reproductive situation (Matthysen 1990). There is a vast gap in the information about various aspects of behavioural studies such as seasonal congregation, segregation, group composition and sex ratio.

Pheasants show a variety of social organizations (Ridley 1982). The first accounts about the social organization patterns known to us are from the works of various naturalists who had observed these birds. (Beebe 1918-22, Delacour 1977, Collias and Collias 1967, McBride *et al.*, 1969, Lelliot 1981)

Pheasants maintain different social units, which are attributes of their biological calendar which brings variations in the group size and composition of a particular species.

Most of the Himalayan pheasants live in groups, interacting with other individuals at least during some time of year. The Himalayan pheasants have been observed to form flocks during winter as they move down to the lower altitudes to avoid harsh winter, as there is scarcity of food resources and shrinkage of suitable habitats. Living in group gives the advantage of minimizing the risk of predation (Hill and Robertson 1988a). Study of group size and sex ratio can produce insight about the population dynamics, dispersal, and interactions within of population and will help in formulating management implication.

The group size and the sex ratio in Cheer pheasant and Blood pheasant have been reported in winter (Ridley 1982). Gaston (1980) assumed an equal sex ratio in many Himalayan pheasants including the cheer which are considered to be monogamous species and suggested the total breeding population could be obtained by doubling the numbers of the calling males. Kaul (1989) observed the flocking of cheer in winter before the breeding season and found these family units broke up before the start of breeding season. However, similar data is lacking for Himachal Pradesh in general and Majathal–Harsang WLS in particular. Therefore, studies on the social organization of Cheer pheasant were done in Majathal– Harsang WLS with following objectives:

1) To study the flock size and composition.
2) To see any changes in the flock size and composition in different seasons
3) To study the sex ratio of the Cheer pheasant.

6.2 Methods:

During the systematic monitoring of the Cheer pheasant data on sex, flock size and the habitat in which these flocks were seen were noted. Each sighting of the cheer was considered as one flock. Within each group, the numbers of males, females and juveniles were noted. The general habitat in which a group was sighted was also noted down.

6.3 Data Analysis:

Non-parametric tests were used for the analysis of the entire data set (Siegel 1956, Folwer and Cohen 1991). One-way analysis of variance (ANOVA) was used to determine differences in flock size between seasons. Descriptive statistics were obtained by using SPSS 11.

6.4 Results:

6.4.1 Flock Size:

The total of 160 groups ware sighted during the study period. These groups were used to describe the flock size in the cheer pheasant. The maximum sightings were of flocks of 2-3 birds which accounted for 61 % of the observations, while single bird was sighted at 20 occasions which accounted for 12 % of the sightings, while 4 birds counted for 7 % of the observations and while more than four birds counted for 20 % of the observations across the seasons (Table 6.1 & Figure 6.1).

The over all mean flock size in the non- breeding season was 4.55 (± 0.353 S.E.) birds per flock (Table 6.2). The highest mean flock size was found in dense and open pine habitats while the lowest mean flock size was found in grassland habitat. The mean flock size did not varied significantly across the habitats (df = 3, F = 1.133, p = 0.350, One-way ANOVA).

In winter the over all mean flock size was found to be 3.79 (± 0.927 S.E.) birds per flock (Table 6.3). The highest flock size was observed in dense pine habitat while the lower flock size was observed in grassland habitat. The mean flock size varied significantly across the habitats (df = 3, F= 4.874, $p < 0.05$, One-way ANOVA).

During spring season, the over all mean flock size of the cheer pheasant was 2.16 (± 0.106 S.E.) birds per flock (Table 6.4). The highest mean flock size was found in scrub while the lowest mean flock size was found in grassland habitats. The mean flock size did not vary significantly across the habitats (df = 3, F = 1.65, p = 0.236, One-way ANOVA).

6.4.2 Flock composition:

A total of 507 birds were sighted in 160 groups. In post breeding season, 173 birds were sighted in 38 groups (Table 6.5), while in winter 163 birds were seen in 43 groups (Table 6.6) and in spring season 171 birds were seen in 79 groups (Table 6.7). The number of males was more on all the seasons.

Table 6.1. Over all flock size of Cheer pheasant in Majathal- Harsang Wildlife Sanctuary.

			Flock Size				
S. No.	**Habitat**	**N**	**1**	**2**	**3**	**4**	$\geq$ **5**
1	Dense-pine	14	3	0	4	1	6
2	Open-pine	24	4	8	6	0	6
3	Scrub	51	6	16	13	5	11
4	Grassland	71	7	28	21	6	9
	Total	160	20	54	44	12	32

N = number of observations

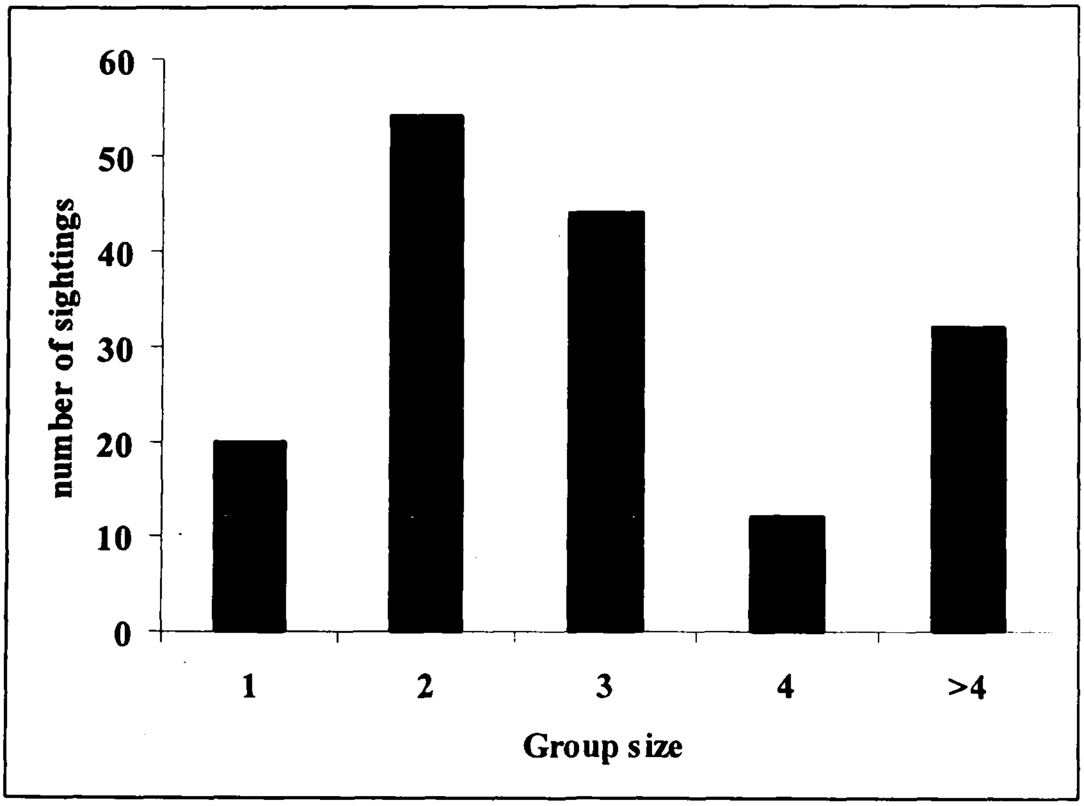


Figure 6.1 Flock size of Cheer pheasant

Table 6.2 Mean flock size of cheer pheasant in non- breeding season.

S. No.	Habitat	N	Mean flock size	± S.E.	Minimum	Maximum
1	Dense-pine	1	6.00		6	6
2	Open-pine	4	6.00	1.472	3	10
3	Scrub	11	4.82	0.600	1	8
4	Grassland	22	4.09	0.451	1	10
	Total	38	4.55	0.353	1	10

N = number of observations, S.E. = Standard Error

Table 6.3 Mean flock size of cheer pheasant in winter season.

S. No.	Habitat	N	Mean flock size	± S.E.	Minimum	Maximum
1	Dense-pine	7	5.29	0.778	3	8
2	Open-pine	5	4.60	0.927	2	7
3	Scrub	8	4.50	0.707	3	8
4	Grassland	23	2.91	0.273	1	8
	Total	43	3.79	0.280	1	8

N = number of observations, S.E. = Standard Error

Table 6.4 Mean flock size of cheer pheasant in breeding season.

S. No.	Habitat	N	Mean flock size	± S.E.	Minimum	Maximum
1	Dense-pine	6	2.33	0.667	1	5
2	Open-pine	15	2.33	0.195	1	3
3	Scrub	32	2.38	0.189	1	6
4	Grassland	26	1.96	0.117	1	3
	Total	79	2.16	0.106	1	6

N = number of observations; S.E. = Standard Error

Table 6.5 Flock compositions of Cheer pheasant in non-breeding season

			Number of individuals				
S. No.	**Habitat**	**N**	**Male**	**Female**	**Juvenile**	**Unidentified**	**Total**
1	Dense pine	1	1	1	4	0	6
2	Open-pine	4	8	7	9	0	24
3	Scrub	11	16	13	24	0	53
4	Grassland	22	30	20	39	1	90
	Total	38	55	41	76	1	173

N = number of observations

Table 6.6 Flock composition of Cheer pheasant in winter season.

			Number of individuals				
S. No.	**Habitat**	**N**	**Male**	**Female**	**Juvenile**	**Unidentified**	**Total**
1	Dense pine	7	18	15	4	0	37
2	Open-pine	5	12	6	5	0	23
3	Scrub	8	16	10	2	8	36
4	Grassland	23	36	24	0	7	67
	Total	43	82	55	11	15	163

N = number of observations

Table 6.7 Flock composition of Cheer pheasant in breeding season.

			Number of individuals				
S. No.	**Habitat**	**N**	**Male**	**Female**	**Juvenile**	**Unidentified**	**Total**
1	Dense pine	6	7	7	0	0	14
2	Open-pine	15	17	10	0	3	30
3	Scrub	32	39	26	0	11	76
4	Grassland	26	28	23	0	0	51
	Total	79	91	66	0	14	171

N = number of observations

The number of juveniles was more in the post-breeding season while there were no sightings of juveniles in the breeding season. The number of the unidentified individuals was 30 across the seasons. There was no significant difference in unidentified individuals between breeding and in winter season. There was only one sightings of the unidentified individual in the post-breeding season.

6.4.3 Sex ratio:

The male to female sex ratio across the season is given in table 6.7. The over-all sex ratio across the seasons was 171:100 males per females. The sex ratio in non-breeding season was 134:100 males per females, in winter season it was 167:100 males per females and in spring it was 137: 100 males per females (Table 6.8). The sighting of the males was generally higher in all the seasons. There was no significant difference in the sex ratio between the seasons (df = 2, F = 0.218, p = 0.804, One way ANOVA).

Table 6.8 Sex ratio of the Cheer pheasant in Majathal -Harsang Wildlife sanctuary in different seasons.

Sex	Non-breeding season	Winter season	Breeding season.	Total
Male	55	82	91	228
Female	41	55	66	162
Total	96	137	157	390
Sex ratio	134 : 100	167 : 100	137 : 100	171 : 100

6.5 Discussion:

In the Cheer pheasant, flock size of 2 – 3 birds accounted for 60% of the groups seen while the mean flock size of Cheer pheasant across seasons was 3.16 birds per group. Living in groups is considered to advantageous since it enables the animal to find food more easily because less time is spent in scanning for predators. The improved vigilance gained by the individuals in a flock also means that more time is spend in feeding (Cararco *et al.*, 1980, Kerbs and Davis 1993, Hill and Robertson 1988a, Reyonlds *et al.*, 1988). During winters, food becomes a scarce resource and with low temperatures, conservation of energy becomes a necessity. Expenditure of this energy in other activities like maintaining territories during winter would be a very energy intensive process. Cararco *et al.*, (1980) observed that Yellow-eyed junco formed flocks containing an average of seven birds at 2° C and at 10° C the flock contained only two birds.

Kaul (1989) stated that with the increase in the flock size in Cheer pheasant, vigilance also increased thus reducing the chances of predation. It has also been observed that individuals in a group are less prone to predators as compared to solitary individuals (Kenward 1978). The mean reaction distance of the pigeons increased with the increase in the group size against goshawk attacks (Kenward 1978) while the potential predators were detected sooner in larger colonies than in smaller ones in Sand martins *Riparia riparia*. There was a significant difference in the flock size of the Cheer pheasant between breeding and non-breeding season. The flock formation in non- breeding season can probably be attributed to the scarcity of food in winters and also for defense against predators.

The sightings of the male Cheer pheasant were much higher than the females and juveniles. A similar trend was observed in Western tragopan in Pakistan (Islam and Crawford 1992) and in Satyr tragopan in India (Khaling 1988). These observations suggest that males were easier to sight and thus were more frequently encountered as the males called, defended their territories and guarded females. This resulted in their being sighted more frequently as compared to the females. Chances of sighting or locating the male birds were further enhanced by the calls that they emitted during the breeding season. In contrast, the behaviour of females was cryptic due to mortality risks associated with incubation (Brown and Gutirezz 1980).

The sex ratio in the cheer pheasant was skewed towards males in all seasons. This would suggest that probably there is always a dearth of females in the population. Studies on the sex ratio are of primary importance in determining the population dynamics of a species and also in predicting the abundance from the call counts (Dale 1952). Johnsguard (1973, 1983) suggested that there is always an excess of adult males in a monogamous population. The 1:1.5 (female: male) ratio was obtained for Western tragopan by Islam & Crawford (1992) while Khaling (1988) reported the sex ratio of 1:1.5 (female: male) for Satyr tragopan. An equal sex ratio was observed in a population of Cabot's tragopan in China (Zhang Junping and Zheng Ghan Mei 1989).

Chapter 7

Threats

7.1 Introduction

Galliforms and humans have been closely associated throughout much of the history. They are large terrestrial birds, are easy trapped and their meat and eggs provide rich source of protein. The explosion of human population has given rise to over-exploitation of the resources from the wild. The threats to the family Phasianidae are highest in the south East Asia, the Himalayas and China (McGowan and Gillman 1997). Pheasants are threatened as a result of human activities, which may affect them directly or indirectly. Many of the threats faced by the pheasants are due to their close association with humans.

Most of the pheasants belong to the narrow temperate zone (50 - 100 km wide and 2000 km long), which is intermediate between the tropical and the palaearctic zones (Gaston *et al.* 1983a). This narrow zone of fragile ecosystems is fragmented by extremes of anthropogenic pressures. During the past 150 years, changes in agricultural practices, intensive grazing by the domestic livestock and increased demand for timber due to increase in human population has led to a decrease in the forest cover throughout the Himalayas (Cronin 1979, Schaller 1980). In Himalayan forests, the reduction of forest area together with habitat fragmentation has made wildlife species like pheasants vulnerable to local extinction (Diamond 1974, Terborgh and Winter 1980).

In developing countries there are debates still going on what should be the first priority, Conservation or basic needs of the local people. The main attributes of local people that influence conservation attitudes, habitat management and resource harvest should be identified and incorporated in the management strategies.

In Majathal-Harsang WLS, local people make use of the resources of the sanctuary for a number of purposes. The objectives of this part of the study were to:

1. To know people's knowledge about cheer.
2. To quantify and document the resource use.
3. To document the threats faced by the Cheer pheasant.

7.2 Methods:

During the study, a total of 67 interviews using a set of questionnaire were conducted with locals in 11 villages around the sanctuary. Interviews were conducted in their local language. Fully randomized sampling was not possible as interviews were conducted through interactions (through questionnaires). Therefore, people available at that point of time were interviewed. Wherever possible, interviews were conducted with the head of the family.

Habitat pressures like loping, grazing, number of cut stems were documented both in random and cheer plots. The number of dung piles, lopped and cut trees were counted both in cheer and random plots. The distance to village from both cheer and the random plots was also measured.

7.3 Results:

The interviews revealed the knowledge of locals about cheer in the area. Fifty two respondents (77.6%) told us that they had heard the name of the cheer pheasant while 22.4 % (15 respondents) said that they had never heard the name of the cheer pheasant. Out of the number who said they had heard the name of the bird, 64.2% (43 respondents) had seen as well as heard the bird, 11.9 % (8 respondents) had seen the bird but had not heard the bird while 16 % (16 respondents) had not heard or seen the bird. About the status of the Cheer in the sanctuary, 34.3 % (23 respondents) told that the number of the Cheer pheasant had increased over the years, 17.9 % (12 respondents) told that there was no change, 4.5 % (3 respondents) told that the number of the Cheer pheasant had decreased and 43.3 % (29 respondents) were not aware of the status of the cheer population in the sanctuary. All the respondents were unaware of nest structure and composition of the cheer pheasant nest and had never seen the eggs of cheer.

Forty six respondents knew that the bird was hunted by the villagers. Thirty one respondents (46.27 %) told that the bird was hunted, 32.84 % (22 respondents) told that the bird is not hunted and 20.89% (14 respondents) were unaware whether the bird was hunted or not. The hunters used guns. The other methods such as snares or pit-fall traps were not used.

The villagers had different views about managing the grasslands in the sanctuary. A majority of the respondents, 68.7 % (46 respondents) told that the these grasslands were maintained as they harvested them regularly, 17.9 % (12 respondents) were of the view that harvesting as well as burning maintained them, 6 % (4 respondents) were of the view that the grasslands were maintained by harvesting grass and grazing by domestic livestock and 4.5% (3 respondents) were unaware of the way these grassland were maintained. 1.5 % (1 respondent) told that the grasslands were maintained only by burning while 1.5 % (1 respondent) was of the view that they were maintained by harvesting, burning and grazing by the domestic livestock.

The average family size in the village was 7.86 (± 0.49 S.E.) persons per family (Table 7.1). There was no significant difference in family size across the villages. Mean number of males were 4.01 (± 0.28) males per family (Table 7.2) and the mean number of females was 3.49 (± 0.28) females per family (Table 7.3). The number of males and females did not vary significantly across the villages. The average land-holding per family was 1.770 hectare (± 0.176) (Table 7. 4), there were no significant differences between the land-holdings between villages. The total land-holding of the villagers was divided into three categories, which were agricultural land, grasslands and any other form of land such as orchards or plantations. The mean agricultural land was 1.770 hectare (± 0.176) (Table 7.5), which did not varied across the villages. The mean grassland per family in a village was 1.808 hectare (± 0.272 S.E.) (Table 7.6) and the mean grassland holding varied across the villages ($f = 1.996$, $df = 10$, $p < 0.05$ One-way ANOVA). The mean of the other land holding was 0.067 hectare

(± 0.062) (Table 7.7) and the other land holdings did not varied across the villages.

In villages, in and around the sanctuary main occupation of the locals was agriculture. The main crops of the area were maize and wheat while some vegetables like tomato and garlic were also sown. The government employment in the villages constituted of twenty seven percent, while nine percent of the respondents worked as the labour while three percent of the respondents were in private sector jobs.

Fire wood, timber and grass were important resources which locals harvested from the protected area. The people had rights to cut trees which are given by the Forest Department. The mean amount of fuel wood that the villagers extracted per year was 112 head loads per family. The extraction of the fuel wood did not vary across the villages ($f = 1.059$, $df = 10$, $Sig = 0.408$, One-way ANOVA). The mean grass extraction by each family in the whole year was 309.51 head loads, and it did not vary significantly across the villages ($f=1.373$, $df= 10$, $Sig = 0.217$).

Man-animal conflicts are one of the major problems in conservation. Most of the problems arise when wild animals destroy the crop and livestock. In case of pheasants, there are no such types of conflicts. Majority of the people were in favour of conservation, which constituted eighty seven percent of the respondents, seven percent of the respondents did not favour conservation and while six percent of the respondents were unaware of the conservation. Nine respondents were having guns.

Significant differences were found between cheer and random plots. The presence/absence of grass cutting varied significantly between cheer and the random plots ($U= 105611$, $p= 0.000$, Mann-Whitney U test), while the presence/absence of human trails also varied significantly between cheer and random plots ($U= 11670$, $p =0.000$, Mann-Whitney U test). The presence of grass cutting and human trail was more in cheer plots as compared to random plots. There was no burning as well as accidental fire during the study period.

The number of the cut stems was more in the random plots as compared to the cheer plots ($df =1$, $F = 15.897$, $p < 0.05$, One-Way ANOVA) while number of the lopped trees did not vary between the cheer plots and the random plots (df=1, F = 3.246, P= 0.072, One-way ANOVA). The number of the lopped trees was more in random plots as compared to the cheer plots. Distances from villages varied significantly between cheer and random plots (df = 1, F = 6.874, $p < 0.05$, One –way ANOVA). The number of dung piles did not vary significantly between the random plots and cheer plots (df=1, f= 0.050, p = 0.825, One-way ANOVA). The number of dung piles was more in the random plots as compared cheer plots.

Table 7.1 Mean number of family members in different villages in and around Majathal-Harsang Wildlife Sanctuary.

Village Name	N	Mean	± S.E.	Minimum	Maximum
Kangri	8	8.00	1.31	5	16
Matridge	5	8.00	1.10	5	11
Khadi	10	8.20	1.91	4	23
Chamrol	10	6.30	0.45	5	9
Pholodan	7	8.86	2.21	2	19
Janrade	1	4.00	0.00	4	4
Soura	10	7.00	0.82	4	12
Kaldwar	7	8.43	1.95	3	18
Pyrab	4	6.50	± 2.22	3	13
Kathado	2	5.00		1	9
Tanga	3	6.67	1.67	5	10
Total	67	7.46	0.49	1	23

N = Number of Interviews

Table 7.2 Mean number of male members per family in different villages in and around the Majathal-Harsang Wildlife sanctuary.

Village Name	N	Mean	± S.E.	Minimum	Maximum
Kangri	8	3.75	0.56	2	6
Matridge	5	4.20	1.10	2	6
Khadi	10	4.50	3.84	1	14
Chamrol	10	4.20	0.39	3	6
Pholodan	7	5.00	1.11	1	6
Janrade	1	3.00	0.00	3	3
Soura	10	3.70	0.60	2	7
Kaldwar	7	3.75	1.02	1	9
Pyrab	4	3.75	1.44	2	8
Kathado	2	3.00	2.00	1	5
Tanga	3	3.33	1.33	2	6
Total	67	4.01	0.28	1	14

N = Number of Interviews

Table 7.3 Mean number of females members per family in different villages in and around Majathal-Harsang Wildlife Sanctuary.

Village Name	N	Mean	± SE	Minimum	Maximum
Kangri	8	4.25	0.86	2	10
Matridge	5	3.80	0.73	2	6
Khadi	10	4.00	1.01	2	12
Chamrol	10	2.10	0.28	1	4
Pholodan	7	3.86	1.12	1	9
Janrade	1	1	0.00	1	1
Soura	10	3.30	0.37	1	5
Kaldwar	7	4.86	1.12	1	9
Pyrab	4	2.75	0.85	1	5
Kathado	2	2.00	2.00	0	4
Tanga	3	2.33	0.33	3	4
Total	67	3.49	0.28	0	12

N = Number of Interviews

Table 7. 4 Mean Land Holdings in hectare per family per village in and around Majathal-Harsang Wildlife sanctuary.

Village Name	N	Mean	± SE	Minimum	Maximum
Kangri	8	5.500	1.681	1.500	11.667
Matridge	5	3.133	0.755	1.6678	5.833
Khadi	10	3.650	0.814	0.000	8.333
Chamrol	10	1.350	0.194	0.500	2.167
Pholodan	7	5.976	1.906	0.167	13.333
Janrade	1	2.00		2.00	2.00
Soura	10	3.922	0.787	0.250	7.500
Kaldwar	7	2.690	1.080	0.000	8.333
Pyrab	4	2.292	1.261	0.000	5.833
Kathado	2	1.500	1.500	0.000	3.00
Tanga	3	3.00	0.419	0.833	1.667
Total	67	3.407	0.390	0.000	13.333

N = Number of Interviews

Table 7. 5 Mean Cultivated Land Holdings in hectare per family per village in and around Majathal-Harsang Wildlife sanctuary.

Village Name	N	Mean	± SE	Minimum	Maximum
Kangri	8	2.563	0.773	0.667	6.667
Matridge	5	1.400	0.245	0.667	2.000
Khadi	10	1.833	0.450	0.000	4.167
Chamrol	10	1.150	0.137	0.000	1.667
Pholodan	7	1.762	0.653	0.167	5.000
Janrade	1	1.333		1.333	1.333
Soura	10	2.142	0.405	0.083	4.000
Kaldwar	7	1.119	0.339	0.000	2.500
Pyrab	4	2.875	1.403	0.667	6.667
Kathado	2	1.833	0.167	1.667	2.000
Tanga	3	1.056	0.338	0.500	1.667
Total	67	1.770	0.176	0.000	6.667

N = Number of Interviews

Table 7. 6 Mean holdings of grasslands in hectare per family per village in and around Majathal-Harsang Wildlife Sanctuary.

Village Name	N	Mean	± SE	Minimum	Maximum
Kangri	8	2.938	1.063	0.000	7.500
Matridge	5	1.733	0.625	0.833	4.167
Khadi	10	1.817	0.602	0.000	6.667
Chamrol	10	0.200	0.092	0.000	0.833
Pholodan	7	4.214	1.416	0.000	10.833
Janrade	1	0.667		0.667	0.667
Soura	10	1.850	0.520	0.167	4.667
Kaldwar	7	1.571	0.780	0.000	5.833
Pyrab	4	1.708	0.488	0.500	2.500
Kathado	2	1.500	0.167	1.333	1.667
Tanga	3	0.222	0.192	0.000	0.333
Total	67	1.828	0.272	0.000	10.833

N = Number of Interviews

Table 7.7 Mean of other land holding per family per village in and around the Majathal-Harsang Wildlife Sanctuary.

Village Name	N	Mean	SE	Minimum	Maximum
Kangri	8	0.00	0.00	0	0
Matridge	5	0.00	0.00	0	0
Khadi	10	0.00	0.00	0	0
Chamrol	10	0.00	0.00	0	0
Pholodan	7	0.00	0.00	0	0
Janrade	1	0.00	0.00	0	0
Soura	10	0.00	0.00	0	0
Kaldwar	7	0.00	0.00	0	0
Pyrab	4	1.04	.1.042	0	4.167
Kathado	2	0.167	0.167	0	0.333
Tanga	3	0.00	0.00	0	0
Total	67	0.067	0.62	0	4.167

N = Number of Interviews

7.4 Discussion:

Surveys and interviews that utilize local knowledge are widely used in anthropology and sociology (Momberg 1993, Siarait *et al.* 1994, Momberg *et al.* 1996) but very less in the wildlife studies. Problem with the questionnaires and interviews includes lack of precision on the part of the interviewee. In spite of the limitations, surveys and interviews based on knowledge of local hunters may be the most cost-effective method of rapidly surveying large areas. Hart and Upoki (1997) used similar interview techniques to guide the development of forest surveys for the Congo peafowl *Afropavo congenis* in a 125,000 km^2 area of lowland forest in eastern Zaire.

The cheer plots were in close proximity to the villages, unlike other pheasants, which are not found close to human settlements. Lelliot (1981a.b) observed that Cheer pheasant lived close to human activities like livestock, grazing, fuel wood collection and arable farming and birds adapted to all these activities. The number of dung piles was low in cheer plots as compared to random plots, which indicated that low grazing can be beneficial as the birds avoided the plots with high number of dung piles.

The natural resources are exploited by the villagers through their hereditary rights. Locals have rights to graze livestock, cut grass. and collect other non–timber produce. Keeping in view the increase in the human population, there is an urgent need to review the rights of the locals for grazing, grass cutting and timber for the long-term survival of the cheer in the sanctuary. Over exploitation of the habitat must be minimized, rather the areas should be exploited on rotational basis.

Grazing was prevalent in the sanctuary and seemed to affect the cheer to some extent. Gaston *et al.* (1983a) in their surveys in the high altitudes of Himachal Pradesh observed that grazing modified the under storey vegetation considerably and reduced the amount and diversity of shrub and ground cover vegetation. Along the grazing routes, they observed that large areas of meadows consisted of entirely *Rumex sp.* and other nitrophilous herbs. One of the reasons for the decline in the number of Western tragopan population in its range was grazing (Gaston *et al.* 1981). Domestic stocks are also believed to cause changes in the patch matrix of semi-natural habitats and produce monocultures which are typical of most agricultural areas (Hill and Robertson 1988a).

Lopping was also low in the cheer plots. The lopping may not be a direct threat to the species but can affect them undirectly. Gaston *et al.* (1983) found that habitat destruction was important threat to the pheasant in Western Himalayas. The greatest level of the pressures was observed in the lower parts of the temperature forest zone and the most susceptible were species that required dense undergrowth. On the other hand, Picozzi (1985) while studying the human impact on pheasants habitats in Pipar in central Nepal suggested that bamboo harvest was important to the pheasants for the maintenance of continuous ground cover.

In pheasants, 44 taxa (64%) are currently considered top be suffering from over hunting for food and sport (Fuller and Garson 2000). Katti *et al.* (1992) observed that pheasants were among the worst hit by hunting and observed that it was one of the reasons that there was paucity of information about these birds. Gaston *et al.* (1983) attributed the decline of the Western tragopan to human predation in the form of trapping and collection of eggs. The over hunting of pheasants was observed to be the main problem in northeast India (Kaul *et al.* 1995).

A number of respondents told that cheer was hunted for meat in the sanctuary. This was further supported by the fact that there were a number of licensed gun owners as well as unlicensed ones in and around the sanctuary. However, a direct estimation of hunting was not possible because of the reluctance of locals to divulge facts. Goral was favourite with the hunters because its large size provided good amount of meat and that was it was easier to hunt as compare to the cheer. Hunting and poaching of cheer may ultimately be detrimental to the cheer population in the sanctuary and might lead to its local extinction.

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